LIGHTING MERCHANDISING AREAS IN SHOPS

A THESIS
SUBMITTED TO THE DEPARTMENT OF
INTERIOR ARCHITECTURE AND
ENVIRONMENTAL DESIGN
AND INSTITUTE OF FINE ARTS OF BİLKENT UNIVERSITY
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF MASTER OF FINE ARTS

By
Ipek Adaloğlu
January, 1995

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İpek Adalıoğlu tarafından bağışlanmıştır

I certify that I have read this thesis and in my own opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Fine Arts.

Assoc. Prof. Dr. Cengiz Yener

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I certify that I have read this thesis and in my own opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Fine Arts.

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ABSTRACT

LIGHTING MERCHANDISING AREAS IN SHOPS

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M.F.A.

in

Interior Architecture and Environmental Design

Supervisor: Assoc. Prof. Dr. Cengiz Yener

January, 1995

The purpose of this study is to evaluate the factors affecting the lighting design of the merchandising areas and depending on the findings, to achieve lighting criteria that are necessary to constitute a comfortable and attractive selling environment. In order to determine these general criteria, the factors which affect the correct and comfortable perception of the merchandise and the effects of light on color are stated. Afterwards, several methods are indicated in order to avoid glare in the shop windows, and mostly preferred lighting methods are defined. Additionally, light sources, lighting fixtures, lighting systems used for the illumination of the merchandising areas are discussed. Finally, general lighting criteria are obtained for the merchandising areas in shops.

Keywords: Merchandise Lighting, Merchandising Area, Shop Window, Shop.

ÖZET

DÜKKANLARDA SATIŞ ALANLARININ AYDINLATILMASI

İpek Adalıoğlu

İç Mimarlık ve Çevre Tasarımı Bölümü

Yüksek Lisans

Tez Yöneticisi: Doç. Dr. Cengiz Yener

Ocak, 1995

Bu çalışmanın amacı satış alanlarlarının aydınlatma tasarımına etki eden etmenleri araştırmak ve bulgulara dayanarak rahat ve etkili satış alanları oluşturmak için gereken aydınlatma ölçütlerine ulaşmaktır. Bu ölçütleri belirlemek için, malın doğru ve rahat algılanmasına etki eden etmenler ve ışığın renk üzerindeki etkileri incelenmiştir. Daha sonra, vitrinlerde oluşan göz kamaşmasını azaltmak için çeşitli yollar gösterilmiş ve en çok yeğlenen aydınlatma yöntemleri anlatılmıştır. Ayrıca, satış alanlarının aydınlatılmasında kullanılan ışık kaynakları, aydınlatma elemanları ve aydınlatma sistemleri tartışılmıştır. Son olarak dükkanlardaki satış alanları için genel aydınlatma ölçütleri saptlanmıştır.

Anahtar Sözcükler: Eşya Aydınlatması, Satış Alanı, Vitrin, Dükkan.

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1. INTRODUCTION

1.1. The Aim of the Dissertation

Light's powerful impact that is created both on to the space and as well to the human is obvious. Mahnke (1987) indicates that: "For years, the lighting industry adhered to the belief that the only significant role of light is to provide adequate illumination, that it should be an aid in seeing" (47). In today's changing merchandising scene which reflects the life styles and preferences of consumers, lighting is not only a tool for seeing but a concrete design element to accentuate merchandise and create psychological influence affecting people's buying attitudes.

As it is stated by Bauer (1986) that "Lighting is the silent salesperson" (6), it really reinforces the visual communication between the customer and the merchandise itself without using verbal expressions. Only with the help of lighting by lightening, darkening, dazzling, coloring or revealing, it is possible to obtain various kinds of effects and different visual perceptions in order to indicate and accentuate the product that the customer could not escape noticing it. On the other hand, although there are many shops designed with thought and care as a theater stage, it is always possible to see the merchandise which does not show itself and is lost within the display units or in the shop windows because of unconsciously, wrong designed lighting.

Therefore, lighting merchandising areas means more than just to illuminate that space. Novak (1977) indicates that:

> Light, like a message, must be both sent and received. Different lighting sources and types of lighting fixtures transmit their varied light in different ways. The human eye "receives" light, and the brain interprets a "message." This message varies according to the design of the lighting system. It is for this reason that care must be exercised in designing the lighting of stores. Each design has a direct functional impact on ambiance, decor, and sales. Each offers a massage that can either enhance or detract from the store and its merchandise (140).

Due to this importance, there are three objectives of lighting in the merchandising areas:

1- Lighting to attract the customer: The main step to be considered is to attract the customers by providing the optimum desired appearance of the merchandise or creating special effects among the other stores along the street or in a mall of many stores.

2- Lighting to initiate the purchase: As stated in the IES Lighting Handbook (1987): "Buying decision starts when the customer is visually intrigued. The actual purchase is not accomplished until the customer can visually evaluate the merchandise and read labeling through adequate illumination" (8-1).

3- Lighting to complete the sales : Proper lighting is essential in order to constitute a suitable environment so that the customers can examine the merchandise and give their decision whether to buy or not, and

makes the sales personal enable to perform their duties such as packaging, quickly and comfortably.

If properly designed lighting has this powerful impact on the customers and has an inevitable potential to help the increase of the sales, there is a need to think the lighting design considerations, and the important points that provides an appealing and comfortable selling environment.

The aim of this dissertation is to reach a lighting criteria which determines the possible lighting requirements in order to achieve lighting objectives. In this dissertation, it is intended to stress that lighting of these areas is not just locating the lighting fixtures above the counters, or illuminating the shop windows as bright as possible. Instead, in order to obtain quality, quantity and effectiveness of the light in merchandising areas, there have to be common lighting design requirements which lie at the basis of all the shops, each selling different goods. These requirements should be explained in order to contribute the right lighting condition to have the right presentation of the merchandise.

It is hoped that, this study can be helpful for designers when the lighting decisions are given for merchandising areas. Consequently, consciously designed lighting plan does not only constitute the desired selling environment, but also provides economy from the lighting point of view.

1.2. The Structure of the Dissertation

The dissertation is composed of 7 chapters including the introduction and conclusion. The information presented has been obtained by a review of the literature.

Since the comfortable and easy seeing is essential in selling environments, determinant effects of factors like luminance, glare, modeling, size and time to the visibility of the merchandise in shops are analyzed in the second chapter.

In the first part of the third chapter, the functions of both light and color, which are attracting attention, controlling circulation and creating atmosphere are examined. In the second part, the effects of light on the appearance of both the merchandise and the human are discussed since in some cases, human appearance becomes as important as the merchandise itself. Fading, that is one of the major effect of light on color and mostly considered as a problem for the merchandising areas is analyzed in the last part.

The concern of the forth chapter is shop windows, one of the most important merchandising areas. These convey the first impression to the customer of the products on sale. In the first part of the chapter, the types and the recommended sizes of the shop windows are stated briefly. It is a known fact that daylight could obscure appearance of the merchandise which is placed there to be seen by the customer. In most of the shop windows, instead of the merchandise, the reflected image of the customer or the moving traffic is observed. To reduce these unwanted effects of daylight some specific methods have to be considered and are to be stated in the second part. In the third part, mostly preferred lighting systems used to illuminate the merchandise in the window are discussed.

The fifth chapter deals with the illumination of the interiors of the shops and grouped under two main parts: shop profile and the lighting plan. In the first part, some questions are aimed to be answered like how to chose

the suitable lighting condition since there are variety of shops each selling different articles, or how to give the store its intended image at the same time reaching the appreciation of the consumer target group. With the help of "Four-corner philosophy" which has been developed by Philips, these kinds of questions can be answered simply. In the second part, lighting plan that is composed of a selection of lighting sources, lighting fixtures and then lighting systems are discussed under particular sub-titles.

The last chapter contains the conclusions of the thesis.

2. FACTORS AFFECTING MERCHANDISE VISIBILITY

Comfortable and easy seeing is the basic requirement in selling environment so that merchandise can be viewed to its best appearance. Flynn, et al. (1992) mention that: "Visibility refers simply to 'how well an individual can see the task.' A task that can not be seen very well is said to have poor visibility" (45). Parnes (1948) notes that more quickly and effectively the merchandise can be seen, the more the shopper will buy. It is within designer's initiative to create a pleasant atmosphere for people to perform effectively through their sense of vision.

According to Zijl (1955), the following factors should be noted for good lighting conditions in a merchandising area:

> Adequate task luminance.
> Limited contrast in luminance or color between task and background.
> Limited luminance-contrast between background and surrounds.
> Avoidance of glare (134).

Before examining the requirements for the visibility of merchandise, the field of vision in which all these conditions occur has to be defined. As Figure 2.1. illustrates, there are three zones of vision: the total field of vision, the immediate field of vision, and the moving field of vision while traveling through space. Kenneth C. Welch, an authority about store lighting, states that:

Calling the line of our horizontal fixed gaze the central axis, the total field of vision can extend almost 80 to 90 degrees to each side and below this central axis and about 30 to 40 degrees above it. The restricted upward angle is of course due to the eyebrow obstruction. One is only subconsciously aware of general areas and objects in the outer parts of this zone, but can be conscious of and distracted by lesser areas of comparatively greater brightness anywhere within the zone" (quoted in Ketchum, 1954: 57).

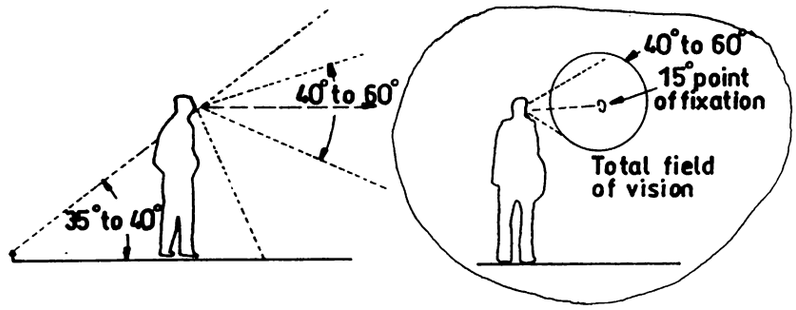


Figure 2.1. The Visual Field

(Ketchum, 1954, p.57).

The immediate field of vision is the zone where one can consciously differentiate the brightness differences and forms within the angle of 40 to 60 degrees. Since the customers are moving all the time around the displays, the scope of the concentrated vision in a more or less horizontal plane increases (Ketchum, 1954).

It is natural to concentrate the gaze downwards if the attention is directed that way. However, particularly for a store, it is less natural to focus the gaze much over 12 to 15 degrees above the horizontal axis. Welch indicates as: "This view-point point is the basic reason why about 45 degrees above the horizontal can be considered as a safe cut-off angle

when shielding primary light sources". Consequently, it is possible to conclude with Welch's words as: " The normal field of vision in a store can be defined as being unlimited laterally and downward, but limited upward as to point of fixation to 15 degrees above the horizontal" (quoted in Ketchum, 1948: 57).

It is always of great importance to contribute controlled selling environments so that customers could appreciate the merchandise on display sufficiently and selling staff could feel comfortable. After defining the limits of the visual field, the requirements of good visibility should be determined. In this chapter, with respect to the merchandising areas, the optical factors that influences the visibility of the merchandise will be mentioned under the following headings: luminance, glare, modeling, size and time.

2.1. Luminance

Luminance can be defined as the amount of light which is reflected from a surface to the observer's eyes. The common term used for luminance is brightness. Luminance of a display is a factor of illumination, i.e., how much light is delivered to the display (lumens per square meter or lux) and how much is reflected back to the customer (candelas per square meter).

The overall apparent brightness of a scene is largely related with the proportion of the light and dark areas in the visual field. As the luminance of merchandise becomes greater, seeing happens to be made easier. For example, under equal lighting conditions, it is easier to distinguish the pattern on a light colored suit than that on a dark colored one; on the

other hand, a dimly illuminated white surface seems much brighter than a highly illuminated black surface. That's why the light colored suit is brighter because of having a higher reflectance value than the dark one. If the illumination level is increased enough, the dark colored suit can be made equally visible (IES Lighting Handbook, 1987 and Green, 1986:).

Luminance of an object always has to be considered together with the luminance of the immediate surrounding. If the difference between two luminances is so high in the zone, the eye has a difficulty to adapt simultaneously to the situation. Lechner (1991) indicates the reason as: "The eye can concentrate on one brightness area at a time, all brightness areas in the field of view have some impact" (26). This is glare.

If a comparison is made between display places and other areas like service or storage, display places should appear brighter than all other task areas, because the main aim of any lighting merchandising areas is to channel the customer's attention towards the merchandise. In other words, the areas that have to be appear bright to the shopper must be carefully selected.

Grosslight (1990) indicates that display and appraisal areas have to be illuminated at similar levels, since different levels create difficulty when buying decision is given. For example if sweaters are displayed in a showcase and appraised in a dressing room, the showcase should not be more than three times as bright as the dressing room.

One point has to be stressed that the background brightness of a display system should not be sō great when compared with the area for the goods to be displayed on sale and their near surrounding. It is possible to control

the luminance of merchandise by arranging the amount and the quality of light falling on a surface, or by the contrast value of its near display background. It is a fact that, to control the reflectance values of the materials on merchandise is difficult but it is more convenient to control the background reflectance values. Goods with a high reflective value, such as light summer clothing, show up best if given a darker background.

Under the scope of the information above, here are some propositions which are required particularly for merchandising areas given by Green (1986), Grosslight (1990) and Illuminating Engineering Society of North America (1986).

1- The luminance ratio between the displayed surface and its immediate surrounding must not exceed 4:1
2- If a noticeable transition from one area to another is desirable one space should be 10 times brighter than another. If only a break in lighting continuity from space to space is required, the ratio should be at least 3:1.
3- If lighting continuity is required, a ratio less than 3:1 should be maintained.
4- Color discrimination will be lost at levels below nearly 30 nits.

The luminance (brightness) of what we see is, therefore, a function of: the intensity of the illumination, the reflectance of a surface, and the luminance contrast. These factors will be examined in the following sections.

2.1.1. Illumination Level

The definition of illumination can be given as the amount of light that is falling on a surface. IES Lighting Handbook (1987) indicates that the variations can be seen in the illumination levels depending on the type of the store, or even in the departments within a store. It is because of the need to accentuate the merchandise according to its specifications and in order to create special effects. Referring Table 2.1. it is possible to see the desirable values for particular locations inside the selling environments.

Table 2.1. Illumination Levels for Lighting Design in Merchandising Areas

Areas or Tasks	Description	Type of Activity	Lux
Circulation	Area not used for display or examination of merchandise	High activity Medium Activity Low Activity	300 200 100
Merchandise (Including showcases and wall displays)	The plane area, horizontal to vertical, where merchandise is displayed and readily accessible for customer examination	High activity Medium Activity Low Activity	1000 750 300
Feature Displays	Single item or items requiring special highlighting to visually attract and set apart from surrounding	High activity Medium Activity Low Activity	5000 3000 1500
Shop Windows	Daytime lighting Nighttime lighting Main business districts Secondary business districts or small towns	General Feature General Feature General Feature	2000 10000 2000 10000 1000 5000
Support Spaces	Alteration room Fitting room Locker rooms Stock rooms, wrapping and packaging	 Dressing areas Fitting Areas 	1000-2000 200-500 1000-2000 100-200 200-500

(IESNA Merchandising Lighting Committee, 1986, p.17).

Illumination levels must be considered not only for the actual merchandising areas, but also for the support areas or the places devoted for the specific visual tasks where wrapping and packaging is done. Table 2.2. shows the illumination levels as lux for the special task areas that are equally important for the merchandising areas.

Table 2.2. Illumination Levels for Lighting Design in Areas Associated with Merchandising Spaces

Area or Tasks	**Illuminance (lux)**		
	Sales Transactions		
Reading Copied Task			
Mimeograph, xerography	200	300	500
Ditto copy	500	750	1000
Thermal copy, poor copy	1000	1500	2000
Reading Electronic Data Processing Information			
CRT screen			
Impact printer, good ribbon; ink jet printer; keyboard reading	50	75	100
	200	300	500
Impact printer, poor ribbon; thermal printer	500	700	1000
Reading Handwriting			
Ball point pen, felt tip pen			
n. 3 pencil and softer leads, carbon copies	500	750	1000
	1000	1500	2000
n. 4 pencil and harder leads			
Reading printed material			
Typed originals, newprints 8- and 10 point type	200	300	500
Typed 2nd copy and later, telephone books	500	750	1000
	Support Services		
Alteration Rooms	1000	1500	2000
Fitting Room			
Dressing Areas	200	300	500
Fitting Areas	1000	1500	2000
Locker Rooms	100	150	200
Stock rooms, wrapping and packaging	200	300	500

(IESNA Merchandising Lighting Committee, 1986, p.18).

It is possible to see the illumination levels of some tasks in Table 2.2. which are commonly occurring in relation with the merchandising areas. However, these areas generally placed apart from the merchandising areas such as in offices or stock rooms. If two or more tasks occurring at the same time requiring different types of illuminances, it would be true to choose the higher level.

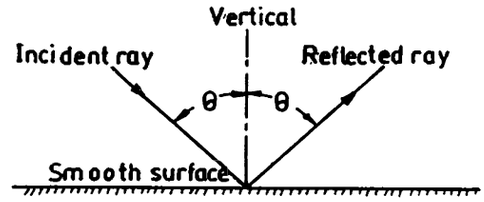
One thing has to be noted that these values showing illumination levels must be considered as a guide for the designers and it is a fact that the values seen will be modified periodically as further study indicates need for a change (IES Lighting Handbook, 1987).

2.1.2 Surface Reflectances and Textures

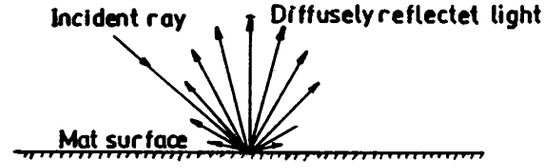
When light strikes an object, some amount of it is absorbed, some transmitted and the rest is reflected. The reflectivity of a surface is largely depends on both its material and its color. At the same time, the nature of the surface determines the extent of its luminance (brightness), since the reflectivity of a surface also influences how bright the surface seems to be.

The nature of the surface is directly responsible for the reflectivity of the incident light. Surface characteristics of a material can be classified as specular (mirror like), or totally diffuse (matte). Since matte surfaces have irregularities in the texture, they scatter all the light rays to several directions; whereas specular ones reflect the ray with the same angle of the incident ray. There are other surfaces neither specular, nor matte but a combination of both. They are called preferential surfaces. The brightness distribution of these surfaces depends on the illumination distribution and

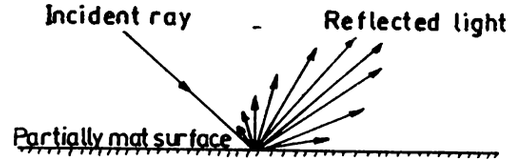
the surrounding luminous field. Figure 2.2. shows the surface characteristics and light reflectances from these surfaces.



Specular Reflection



Diffuse Reflection



Preferential Reflection

Figure 2.2. Types of Reflections

(Philips Lighting, 1964, p. 94).

As stated in IES Lighting Handbook (1987), for specular surfaces; the direction of viewing, the location and size of the light and its luminance, and the degree of specularity change the brightness appearance. Since the reflection is totally diffuse in matte surfaces, the surface will be seen same when viewed from all directions.

Lechner (1991) mentions that; the reflectance factor indicates how much of the light falling on a surface is reflected. Table 2.3. showing the reflectance percentages of some materials.

Table 2.3. Reflection Values of Some Materials

LIGHT REFLECTED FROM VARIOUS SURFACES	
Surface	**Per cent of Light Reflected**
Aluminum Finish (Sheet Aluminum)	80-85
Polished Silver	92
Mirrored glass	82-88
White Blotting Paper	80-85
White Paint	75-85
Black Paint	3-5
Aluminum Paint	60-70
White Plaster	90-92
Marble	30-70
Granite	20-25
Light Oak	25-35
Dark Oak	10-15
Mahagony	6-12

(Parnes, 1948, p.169).

It is true that the luminance level of the surfaces can be controlled by changing the illuminances on the surfaces. As stated in section 2.1. darker surfaces require higher level of illumination, while lower level is appropriate for the lighter ones. Nevertheless, light-colored objects have a greater reflectance factor, they will always appear brighter than dark-colored objects under the same light source with the same background.

2.2.3. Luminance -Contrast

Ketchum (1954: 66) states that good visibility depends more on contrast rather than brightness. Steinmetz indicates the importance of contrast in both color and luminance, saying:

> Objects are seen and distinguished by differences in quality, that is, color and in intensity, that is, brightness, of the light reflected by them. If there were no differences in color or in intensity throughout the field of vision, we would see light but would not distinguish objects. Therefore, in good illumination, the differences in color and in intensity should be sufficiently high to see clearly by them, but still limited so as not to distract the attention from smaller differences" (quoted in Ernhardt, 1977: 316).

Under the light of the information above, in order to constitute a comfortable and distinguished vision, it must be noted that the difference in the intensity should be high enough to give distinction to the product from its near surrounding. At the same time it is restricted to a degree not to cause fatigue and contraction of pupil.

Since too much contrast results with glare, and the uniform brightness makes the products appear invisible, the intensity of the light must be sufficient. In addition, the background materials and their reflection values play a vital role for determining the luminance contrast. In order to achieve a proper luminance contrast, the possibility of reflected glare has to be considered while choosing the background materials. Too much reflectance from the background reduces the contrast with the displayed object, as well as obscuring the appearance of the merchandise (see section 2.3.). Matte surface materials as a background could be used in order to reduce the risk of reflected glare since they scatter the incident light.

In this respect, in order to achieve a proper brightness contrast, it would be wise to differentiate the display and the circulation lighting intensities. If it is to be classified; low brightness in the aisles, higher brightness of

If it is to be classified; low brightness in the aisles, higher brightness of the merchandising areas and counter displays, also higher for special accent displays could be preferred (Parnes, 1948). Table 2.4. shows the relationship between intensities and the areas.

Table 2.4. Showing Intensities Between Areas

1 UNIT	3 UNITS	5 UNITS	10 UNITS
Circulation Area 200 (150-300) lux	Merchandising Areas 600 (300-700) lux	Showcases, Shelves 1000 (700-1500) lux	Feature Display 2000 (1500 up) lux

(Parnes, 1948, p. 232).

According to the table above, one unit of illumination is defined as 200 lux. For elevators, entrances, and other services where product discrimination is not necessary, one unit of illumination is essential. For the merchandising areas, it is 3 units, whereas for the display cases, counters requiring localized lighting it is 5 units. Finally, feature displays need the highest level of illumination as 10 units (Parnes, 1948 and Ketchum, 1954). These intensities have to be considered with a minimum glare and a moderate amount of shadow contrast as examined in the following sections.

2.3. Glare

The main purpose of illuminating a place is to establish a comfortable and productive environment for people without having glare. This enables the observer to perceive the merchandise and maximize the ability to see the fine details clearly. However, in practice, it is difficult to arrange light sources and illumination levels without causing glare. It is a fact that,

illumination which is directed towards the human eye as well as reflecting from surfaces within the field of vision, may result as what we call direct and reflected glare.

Glare occurs when there is a great level of brightness in the field of view than the general level which the eye is adapted. In a way, it is a result of excessive contrast. Some reflections may decrease the contrast between the details and the backgrounds, so the merchandise is obscured by these "veiling" reflections and glare appears as well. In merchandising areas, veiling reflections are caused by reflections in packing materials and glass surfaces in front of products such as counter tops and shop windows. Veiling reflections occurring in shop windows and methods used to avoid them will be discussed in detail in section 5.2.

Glare may either lessen the ability to see, what we call disability glare, or can cause discomfort; that is discomfort glare. Steinmetz explains the cause and effect of glare as:

> The pupil of the eye automatically reacts , by contraction, to high brilliancy at or near the sensitive spot, that is, the point of the retina on which we focus the image of the object at which we look at . . . If, therefore, points of areas of high brilliancy are in the field of vision, especially if near to objects which we look, the pupil contracts the more the higher the brilliancy, and thereby reduces the amount of light flux which enters the eye . . . intensified by the uncomfortable effect of seeing brilliancy. Points of high brilliancy thus must be kept out of the field of vision. (quoted in Ernhardt, 1977: 267).

In this context, there are several ways to avoid glare as stated by Philips (1964), Flynn, et al. (1992) and IES Lighting Handbook (1987). These are the following:

1- Controlling the luminance levels by: reducing the luminance of the source; reducing the area of the source seen from normal viewing angles; increasing the illuminance of the immediate surroundings of the source.
2- Shielding the light sources out of sight by using baffles and louvers.
3- By relocating the source outside of the visual field.
4- Reducing the reflectance characteristics of excessively bright surfaces.
5- Positioning light sources so that they will not be above or behind the customer as seen Figure 2.3.

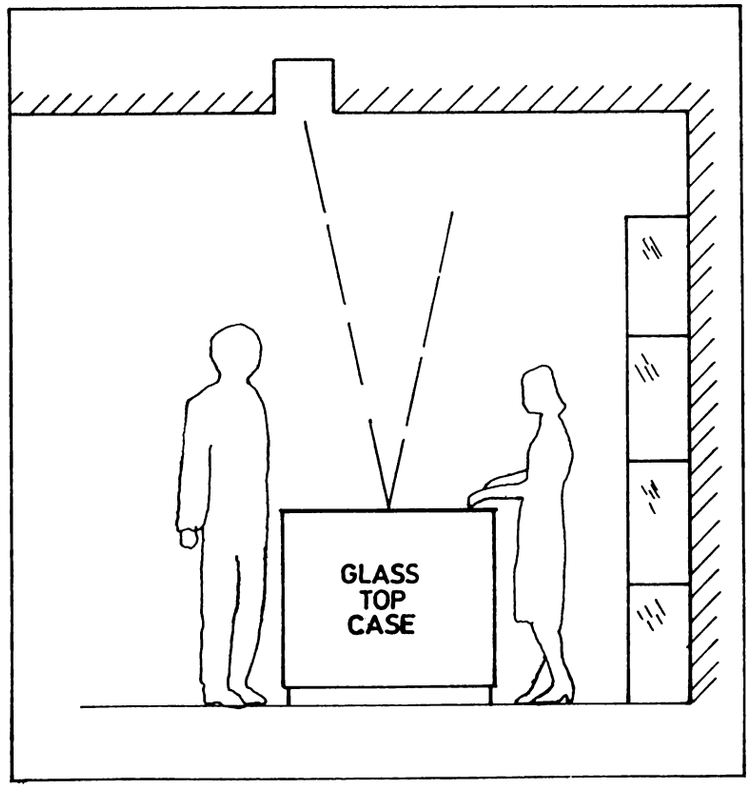


Figure 2.3. Location of the Downlighting Units

(IESNA Merchandising Lighting Committee., 1986, p.35).

Consequently, when the minimum amount of glare is introduced inside the selling environment, a greater visibility of the merchandise will occur. The reflections provided in order to show the merchandise, must enhance the appearance of the product, not obscure the whole details and veil the appearance.

2.4. Modeling Effect

Diffused light removes all the shadows, creates a flat and monotonous appearance; it is the incident light which gives them a three dimensional effect, this is called modeling. Modeling effect is essential for the visibility of the merchandise in order to discriminate the form and the texture of the products on display.

Ketchum (1954) indicates that: "The degree of modeling and shadow depends on the luminances in the whole field surrounding the object, including the light sources; it is an important concept to specify designed appearance. Small sources produce sharp shadows; large sources produced soft-edged shadows" (59).

As stated Philips Lighting Handbook (1993), the direction of the light is very important for defining the modeling effect. It is stated that:

> The greater the angle of incidence (light from above), the more dramatic is the effect obtained and the more accentuated is the texture of the material, although the ability to identify the object may actually diminish. The smaller the angle of incidence (light from the front), the greater the chance of reflected glare (238).

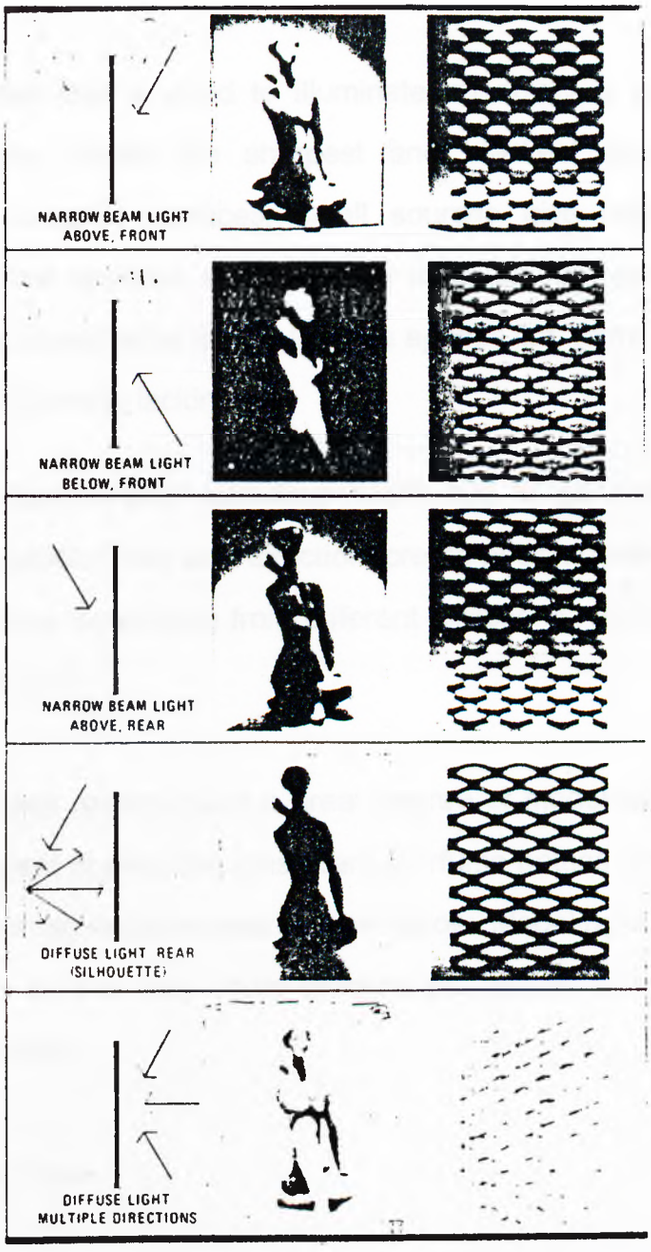


Figure 2.4. Influence of Light Direction on Texture and Pattern (Flynn, E.J., et al., 1992, p.53).

Figure 2.4. presents the influence of light rays coming from different directions with different angles, both on texture and form.

The source size that is used to illuminate an object is important. The smaller sources create the sharpest and blackest shadows. When reflected off specular surfaces, small sources give minute sparkling highlights. At the opposite extreme, very large sources provide minimal highlights and almost no shadow. Objects appear flat, forms obscure, and texture is almost totally lacking.

It is stated by Gardner and Hannaford (1993) that: "In general, single types of source, emanating from one direction, create poor modeling, whereas a mixed of sources, emanating from different directions, will tend to create the best effect" (11).

Some retail tasks require quite a great degree of modeling effect; others none; transparent objects like glassware, perfume bottles or such are best presented when lighted from rear or from below. Modeling is necessary for the customers so that they could examine the texture of a fabric or of a sculpture, properly.

2.5. Size and Time

The size of an object and the time taken to see it are two determining factors comprising the requirements of visibility. As size increases, visibility increases and seeing becomes easier up to a certain point. Also when the size is small, it is possible to enhance the visibility by increasing illuminance.

Ernhardt (1977) states that: "There is evidence to support the belief that the light level at which visibility begins is inversely proportional to both time and area. The smaller the object or the shorter the viewing time, the higher the illumination that will be required to cross the threshold of visibility" (86).

Helms (1980) indicates that the most important aspect for the visual acuity is not the physical size, but the retinal size. He says that:

> . . . the size of an object modifies the size of the image on the retina. In fact, the important aspect of size is not the physical size of the object, but the visual angle that the object subtends at the eye. When an object is brought closer to the eye, we are actually increasing the visual angle and making the object clearer (17).

Figure 2.5. clearly illustrates the Helm's words.

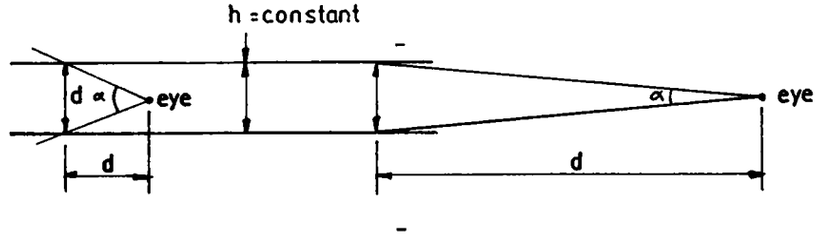


Figure 2.5. Physical Size Versus Visual Size

(Helms, R.N., 1980, p.17.)

Therefore, the visual angle is an important aspect when the visibility requirements are considered and if more time is devoted to the inspection of the product, it is obvious that more details will be seen instead of a quick look.

3. EFFECTS OF LIGHT ON COLOR AT MERCHANDISING AREAS

As it is known that, color is used as an important visual selling element. According to sales figures, it is obvious that right colors sell. Especially for some products, color is an important factor to achieve maximum sales (Danger, 1987). Color values and color compositions can be used to accent and identify the merchandise, as well as provide the character of the store front or the sales space when used in an appropriate and creative way.

The appearance of the merchandise and its relation to the surrounding determines the customer appreciation whether to pay or not for the apparent merchandise. In order to determine the appropriate color for the merchandising areas, Judd and Wyszecki (1975) offer these factors to be considered:

1- Suitability to the merchandise.
2- Harmony of colors.
3- Illumination suited both to the merchandise and its background (41).

Generally, color choices for merchandising areas begin with the merchandise color itself. Characteristics of the products on sale are determinant factors for contributing the color scheme around it. Well chosen colors, in combination with good lighting, can show the merchandise appealing, stimulate sales and constitutes the overall atmosphere of the store.

The aim of this chapter is to examine the affects of light on color. The functions of light and color in merchandising areas will be stated in the first section. In the second section, factors that affect the appearance of color are considered with regard to both people and object's appearances. One of the major problems of the merchandise lighting is the color fading of the products. This subject is deeply analyzed in the last section of the chapter.

3.1. Functions of Light and Color in Interiors

The main aim of all selling environments is to sell merchandise and lighting is essential in any selling environment since without it, it is impossible to see the merchandise. It is a matter of fact that adapting general lighting rules may become difficult because many specific components depend on the type of the establishment, the kind of the products sold and the design of the interior space. But what does not change is the inevitable impact of color and light can do to any store environment.

The main functions of color and light; attracting attention, controlling circulation and creating an atmosphere. are basic concerns of this discussion which will be analyzed in detail.

3.1.1. Attracting Attention

The main aim of any selling environment is to catch the attention of the passers by, stop them to look at and enter the shop in order to examine and see the merchandise which in the end may result buying it. This could be possible by contributing a favorable impression which people are convinced to enter in it. At first glance what attract attention is the exterior

lighting, in particular lighting of shop-window if it exists. In some cases, even a brilliant sign can be the central point of attention.

As mentioned in the second chapter, brightness patterns catch attention whereas dimness is passed by. If there is a shop-window, brightness inside it stimulates visual and emotional response of the customer and may initiate a motion towards inside the door. In other occasions where there is not a shop-window, the main entrance could be the focal point of brightness backed up by a brightly lit reception area (Danger, 1987). Therefore within the field of vision, highest level of brightness which draws desired attention normally be on the merchandise in the window but for the other situations, a sign or the entrance facade are likely to be the attraction points.

When the customer enters inside, the impression of the interior as a whole is extremely important since the customer may turn away if the appearance is unsatisfactory. In order to attract people, it is of great importance to use appropriate color selection to the kind and nature of the trade, to the atmosphere and the image that aimed to be created. Danger (1987) indicates that:

> The fact that some colors attract and others do not, is tied up with the way the eye sees and the brain perceives. Because the eye is primarily a lens, the brain is the organ that makes sense of what the eye sees, and the image registered on the brain is affected by the conditions under which the eye records the image. Long before color becomes associated with coolness or warmth or other emotions, it imposes itself in a primitive way. When the eye views the spectrum, the brain will immediately sort out the elemental hues -red, yellow, green- and the simplest form of these colors will attract

> attention most easily, irrespective of likes and dislikes; the brighter the color, the greater the attraction, because brightness stimulates eye to a great extend (93).

According to Birren (1988) and Danger (1987), yellow is the point of highest visibility in the spectrum, the region where there is greatest brightness. Other ones that follow in order are orange, red, yellow-green.

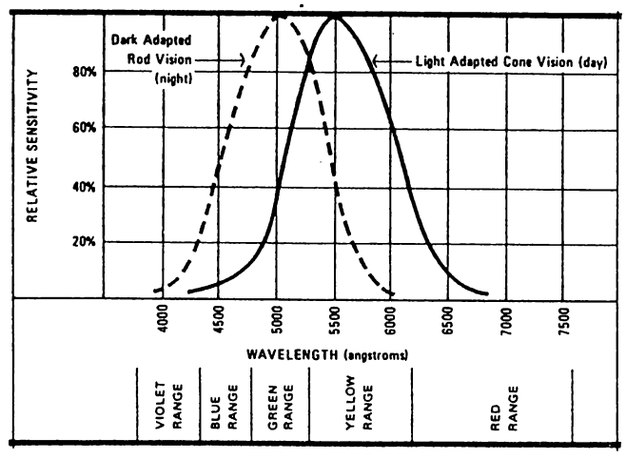


Figure 3.1. Eye Sensitivity

(Flynn, et. al., 1992, p.4).

Regarding the appearance of colors, the warm colors will advance while cool ones will retire. When white light passes through a prism, prism separates it into different color bands. Some colors are refracted slightly (red), some are more sharply (blue). Birren (1988) states that:

> Being only slightly refracted by the lens of the eye, red will focus at a point behind the retina. To see it clearly, the lens will grow more convex, thus pulling the color forward, making its image larger. Blue will be more sharply refracted and will cause the lens of the eye to flatten out. This will push the image of blue back and decrease its size (40).

Colored light could be another consideration in order to attract attention, particularly when used at night for the illumination of the buildings' exteriors. It could be a good solution to distinguish the one shop from the other and draw attention.

Therefore, colors that are used for the merchandising areas must be appealing. Starting from the outside; a well lighted sign or shop window could give the first impression and direct attention. Last but not the least, too much impulse colors are self-defeating (Danger, 1987). It could be not only destructive but also psychologically uncomfortable and since it would be difficult to choose where to look at; the merchandise or the colorful display surfaces or walls.

3.1.2. Controlling Circulation

Controlling circulation means, in effect, making sure that potential customers who have been attracted by the exterior of an establishment and persuaded to enter it, do not lose interest once they are inside (Danger, 1987).

It is a fact that lighting is more likely to control the traffic than color (Danger, 1987). First of all, it must be considered that the customers entering inside are coming from the daylight condition which the illumination level is high. Lighting level inside the selling environment must be high enough for their eyes to readapt the inner situation. If the level is low, it will take time to readapt and within this period of time, possibly, the customer may loose interest. Such a problem does not exist at night since the eye has already been dark-adapted. As Danger (1987) states that; "Eye adapts more quickly to brightness than it does to dimness" (337).

Customers always have a tendency to be directed towards the high brightness areas. They are likely to be denser in places where brightly lit, than the areas where there is not enough light and can be left more or less deserted. Using more light and bright colors on the back walls helps them to direct towards inside. According to Danger (1987), better traffic flow can be achieved by using brighter colors around the periphery of an area, and brightening up dark corners will move people away from the center of the area. A reasonably bright colored floor, perhaps with a directional pattern, will induce people to move in a desired direction, and where appropriate, increasing the use of light and brightening colors on the walls of corridors and staircases will encourage people to explore.

According to Fitch and Knobel (1990), generally for the circulation paths lower level of illumination is needed when compared to the display areas. The actual pattern of lighting can establish the apparent circulation areas. It is possible to do it by using a light track that follows the circulation path or a neon stripe that defines the walkways and circulation paths by its appropriate color and intensity.

In addition to the design of a lighting system, the treatment of the ceiling, and the color of the floor will help to direct customer's movement. Ease of movement is also a matter of planning the display elements. They could be planned in a way to allow the traffic flow. Color, as well, can be used to separate the departments from each other. Color used for the signs is also an affective way to guide customers to the different sections.

When light rays falling on a surface, some amount is absorbed or transmitted and others are reflected. This reflected value expressed as percentages and important in order to provide a satisfactory environment

(see section 2.1.2.). For the circulation areas, recommended reflectance value is up to 70 percent. Reflectance is related with the lightness of the color perceived: the higher the percentage reflected by the product, the lighter is the color perceived. According to Danger (1987); "Reception areas, entrance halls, areas around escalators and lifts benefit from light colors, which give a sense of space and encourage busy traffic. Good lighting and bright colors are particularly useful in the entrance hall" (337).

Therefore, the decisions about the lighting merchandising areas should be made by the considerations of lighting circulation areas as well. Well designed lighting system helps people to circulate inside the selling environment without any difficulty. It is stated that the bright areas in the field of view make people to direct towards that way and get their attention. Thus, using bright colors on the rear walls or the corners, customers could be led to the point of sales. Change in the color of the floor pattern could be helpful to direct circulation as well.

3.1.2. Creating An Atmosphere

In order to be differentiated many stores on the same street or in the same department store, possibly selling similar merchandise should have an image of their own. In merchandising areas, it is of great importance to contribute an appropriate atmosphere that shows the store image and identity. When customers have entered inside, the overall impression or the feeling that is created inside the store affect them to stay or come again soon. Danger (1987) stresses that; "The selling environment should not only be attractive in terms of design but it should also be visually comfortable and should awaken a response in the minds of the observers.

This response is partly influenced by the type of lighting employed and the way that is used" (338).

The nature of the light source is a vital factor to create the desired appearance of the interior. They could be grouped as warm and cool sources. Cool sources contributes an uninviting environment whereas warm sources are inviting, appealing, sufficient to create an attractive atmosphere. They suggest luxury, comfort, extravagance, while a cooler source has a more clinical effect suggesting cleanliness and efficiency (Danger, 1987). Nuckolls, as well, states about the mood created by the light sources, that is: "Warm lighting throughout the store in random light patterns will create an atmosphere of gaiety and intimacy while general cool lighting in a higher intensity will create a feeling of somberness and detachment (quoted in Green 1986: 113).

Interiors that have saturated colors, lit with low intensities give a feeling of rich quality, cleanliness and a pleasant atmosphere. In some cases if the illumination level is high, cool light can be stimulating otherwise creates dull, uninteresting and depressing atmosphere.

Ernhard (1977) indicates that: "Bright scenes with high color saturation take on a carnival feeling and gaiety and spontaneous exuberance" (315). According to Danger (1987), a colorful environment is best produced by normal light reflected from surfaces such as walls and fittings, and not by tinted light, and therefore it is the color of the surfaces which produce the right atmosphere. We have to note that the overall surrounding and the general atmosphere must not direct more attention away from the merchandise (that is displayed).

The type of the establishment and the customers coming to these places impress the color selection and the general feeling that has to be awaken. As an example, bright colors are generally preferred in the stores for children, or it would not be a good selection to paint all the walls red in a butcher shop. In this respect, color determines the nature of the establishment and must be appropriate according to the type of the merchandise and the customer.

Consequently, color helps to create an atmosphere that refers to the customer's preferences and likes. The more a mood is appropriate for the type of the trade and kind of the establishment whether it is a women's store or a supermarket, the higher the sales will be since they are feeling comfortable and fine, willing to come often. Regarding all these aspects, the nature of the light source that is selected to use, has a dominant influence on the interior atmosphere as well as creating the image of the merchandising areas.

3.2. Color Appearance in Merchandising Areas

It has already been mentioned that color determines the general appearance of interior space; it has a power to enhance proportions, creates visual illusions as a space may seem to look small, wide, or narrow. Light sources used in an environment can affect the total appearance of colors but this becomes more important especially in merchandising areas. Since the main aim is to sell the merchandise and make the customers happy so that they could come again, the good (correct) appearances of the products and for some situations the desired appearances of customers are vital.

When the human face is lit below, there is a high probability to have an unnatural appearance. A dress may seem to be nice but if the woman wearing it sees herself pale and unnatural, she can immediately change her mind and may not buy the dress. This situation, of course, directly influences sales.

The color of the objects can be perceived by means of the source illuminating them. The amount of light which is reflected back to human eye defines the color of that object since the source must emit those wavelengths of light corresponding to the object color. As Grosslight (1990) states: "The color of a product can not be seen unless the color of the product is present in the lighting source" (183).

It is generally accepted that the lighting which is as close as possible to daylight is concerned as the best situation for the illumination of a space. It is more common to observe the customers who tend to step outside for a moment in order to see the color of the merchandise in daylight.

In the following sections, it is aimed to understand how objects and people appear under different light sources in a selling environment. The appearance of objects and people will be examined in detail as well.

3.2.1. Color Appearance of Objects

As stated earlier, color appearance of objects mostly affected by the pigment of the surfaces and objects viewed, and the color of the light sources used in the environment. Light sources like daylight, florescent, incandescent, and HID lamps are regarded as sources of "white light" but

they have different amount of energy in each portion of the visible spectrum, ranging from violet through red (IES Lighting Handbook, 1981).

Colored objects will have different appearances when lit with different light sources: because each light source renders color differently. It is evident to see the difference in color when the same product is first perceived under incandescent lamp then fluorescent lamp.

Color rendering properties of light sources, with respect to the nature of the light source, have a special importance when the color discrimination is necessary. "Aristotle wrote that the colors in embroidery are often mistakenly perceived when observed by lamplight. So color rendering of illumination has obviously long been a problem" (quoted in Thornton, 1982: 33).

As Thornton (1982) mentions, one contemporary merchandiser has 50 million dollars worth of merchandise returned annually because of the problems of color rendering; much of this amount directly bound to the differences in color rendering properties of illuminants. The color rendering properties of light sources are mentioned in section 5.2.1.

Consequently, lighting that is deficient in color rendering property can adversely affect the customers' shopping attitudes. Accurate color judgments can not be made if the color properties of illuminants are not sufficient. In the light of a poor color rendering, apparent color matching of a product may be found false when re-examined under the light of a better color rendering.

Danger (1987) indicates the reason why these different appearances occurs as:

> The human eye sees white when all the receptors of the eye are stimulated equally, and white light consists of all the hues of the spectrum in roughly equal proportions. When there is more energy in one of the wavebands than in the others, the light is tinted with the spectral color of maximum energy and the receptors change their sensitivity to compensate for the extra energy, with the result that the brain receives nearly equal nerve impulses and the light is seen as white. It follows that the color of any object or surface seen will be slightly modified because the eye adapted themselves to the light source. An object of a given color will therefore look slightly different under natural daylight, under incandescent light and under any other type of light (32).

In this respect, what is expected from a lighting system is to show merchandise with the same color appearance as the place it is going to be used. This will minimize the returns and disillusions.

Danger (1987) states that if an extra light source which have a different spectral distribution or different colored object is placed in the field of view, the eye's sensitivity will change again and the small variations could be seen in the appearance of the original object.

According to the displayed object, light source could either enhance or gray the color of the product since the spectral distribution of each source is different. Cool fluorescent illuminants emit large amounts of shorter wavelength, and violet, blue, and green are the colors they accentuate. By contrast, incandescent illuminants emit longer wavelengths, producing

yellow, orange and red hues. Some products can be best presented under incandescent lighting which naturally enhances the colors like reds, browns, and yellows. On the other hand some jewelers such as diamonds must appear clean white so that there is a desire to buy them. Due to this importance, as there will be yellow brilliance, it will not be correct to use incandescent lamps in order to illuminate them. Thus, diamonds should be displayed under a cool light source.

Another specific consideration is the lighting of food. Most food especially bakery products look better when lit with warm light sources. Appearance of meat is also important. Using red lamps or red filters are not recommended since fats seem to appear pinkish and lean look unnatural. To accentuate the contrast between fat and lean, de luxe natural fluorescent or filament lamps are advised to be used (Danger, 1987).

Sometimes, in order to present the merchandise and show off the apparent specialties, backgrounds are necessary elements generally used in selling environments. If the color of the product is similar to its background, visibility is obstructed and more light is required. Depending on the product's color, details may be less visible. Needless to say that the backgrounds must not receive more attention than the merchandise. In an experiment, a shop window is designed with movable panels; each have mirrors in the middle. Instead of noticing the merchandise, all the attention is drawn to the mirrors; customers adjust their hats and ties and passed on (Wingale, 1963).

As far as varying and colorful merchandise is concerned, light reflectance and neutral backgrounds must be used. However, it must be noted that this reflectance value must be more than 55 percent. According to IES

lighting Handbook Application Volume (1987: 8-4); "The use of large areas of strong colors could clash with the color of the merchandise displayed and could adversely affect the color of reflected light reaching the merchandise."

Therefore, in order to have the desired appearance of displayed objects, the type of the light source, incandescent, fluorescent or HID, and the color emitted from the source are of great importance. Generally, for the merchandising areas, warm sources are suggested to be used. Colors must not be exaggerated by using cool sources or filters directed towards the object. Consequently, effects of light on color should be considered in planning the lighting system in merchandising areas.

3.2.2. Color Appearance of People

People's appearance is as important as the merchandise itself because a dull, and unnatural look easily affects the customer's buying attitudes negatively. Using fluorescent light to light a blue textile or blue carpet, creates pale, bad looking faces (Birren, 1988).

Cool light sources are likely to give a particular product its desired appearance but at the same time constitutes an unwanted look on the faces. Surveys show that people prefer light sources towards red when appearance is important because they seem to have a healthy, rosy look. On the other hand, when high level of illumination is desired, most people tend to prefer cool lighting (Birren, 1988).

In 1941, Kruithof made several studies in order to understand the effects of warm and cool light sources on people and objects. He found that

people prefer a cool color temperature when illumination is intense and a warmer color temperature when illumination is low. He also reported that objects and surfaces will have their best color appearance under warm light at low intensity and under cool light at high intensity. It is illustrated with a graphic in Figure 3.2.

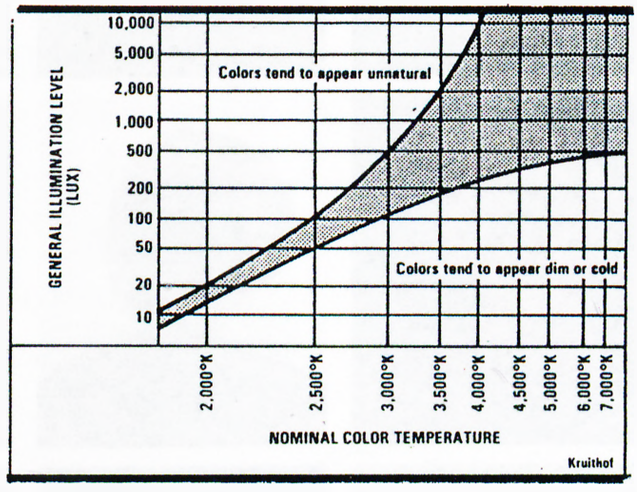


Figure 3.2. Color Whiteness (amenity curve) (Flynn, E.J., et al., 1992, p.44).

Colored light is not advised to use neither on people nor on products. Blue and green lights must be avoided just because they are unflattering and make things look horrible. Candlelight, incandescent light, and warm white fluorescent light are all flattering human complexion.

Figure 3.3. Effects of Light on Human Complexion and Background (Birren, F., 1988, p.65).

Last but not the least, as Danger (1987) indicates that human complexion which is seen against a blue-green background will also seem healthier since blue-green colors are complementary of the human complexion. Figure 3.3. presents different tints in light sources and their effects on human complexion and backgrounds. (a) is daylight with a color temperature of about 6800 degrees. The effect is bluish. (b) is fluorescent light with a temperature of about 5500 degrees. The effect is more or less natural. (c) is cool white with a color temperature of 4300 degrees. The influence of yellow-green can be seen on the face. (d) is warm white with 3000 degrees and comparable to candle light. (e) is a definite pink illuminant. (f), (g), (h), (i) shows the different colored backgrounds on human complexion (Birren, 1988: 65).

Consequently, the color appearance of light has an effect on human appearance. While warm sources are flattering to the appearance, cool sources are not. It must also be noted that for the merchandising areas, where customer's overall appearance is important, lights of mixed spectral quality should be avoided.

3.3. Color Fading

Fading of merchandise is one of the most common problems which is seen in selling environments. Light sources radiate heat and can give harm to products. Some materials such as papers, inks and dyes, can easily be damaged by light or radiation in the short wave region of the spectrum.

The damage presents itself in the form of discoloration, fading and, disintegration. Some products melt like candy, some products discolor as meat. Time spent for the discoloration of a product changes; it could take hours or days. Discoloration of food is caused by changes in the product, including bacterial growth in the warmth of the light. Both melting and discoloration reduce sales potential.

The extent of the damage caused by the lighting, for a given material, depends on three factors: the spectral composition of the radiation, the illuminance on the material, and the duration of its exposure to light.

The spectral distribution of the radiant energy affects the fading rate. According to the IESNA Committee (1986), it has been found that ultraviolet energy of wavelengths shorter than 300 nanometers, which is not present in energy radiated by most light sources, may cause rapid fading. Energy in the region from 300 to 400 nanometers is present in the radiation from most electric light sources in common use but in a much smaller amount per lumen than in daylight. This spectral region apparently produces more fading per unit of energy than an equal amount in the visible spectrum.

The damage potential of a given light source can be expressed in terms of its so- called damage factor. The damage factors of the lamps commonly used in shop lighting are listed in Table 3.1.

Table 3.1. Damage Factors

UV SOURCE	DAMAGE FACTOR
Daylight through 4-mm-thick window glass	0.43-0.68
Incandescent lamp	0.15
Open halogen lamp	0.22
Enclosed halogen lamp	0.17
White SON (SDW-T) lamp	0.10
Open metal halide lamp	0.50
Enclosed metal halide lamp	0.25
Fluorescent lamp color:	
/82	0.19
/83	0.20
/84	0.21
/92	0.07
/93	0.15
/94	0.18
/33	0.24

(International Lighting Review, 1993, p.11).

It is stated in International Lighting Review (1993) that, the damage factor (DF) (stated in the table), illuminance (E, in lux), and exposure time (in hours) are termed the Fading Risk (FR). Thus FR= DF x E x time. FR of 100 is equivalent to the illumination in a shop window under bright summer sunshine for one hour. On the other hand, a lighting level of 500 lux for the same time from tubular fluorescent (TL/83) lamps results in a negligible risk. The fading of the pigments occurs here 50 times more slowly than at FR100.

If open halogen lamps and metal halide lamps are used without UV filters, the risk of fading rises to the unacceptable levels. Luminaries with UV filters, enclosed halogen lamps, or fluorescent or incandescent lamps make the UV radiation minimal.

There is a higher rate of fading in daylight since greater amount of energy exists in the near ultraviolet and blue per lumen of daylight when compared with the light that is radiated by tungsten and fluorescent lamps. IESNA (1986) states that according to the tests that held in 1940's, half of 100 textile specimens faded after exposures of approximately 500.000 to 10.000.000 lux-hours to fluorescent lamps under controlled conditions. Henderson, LaGiusa and Gowan (1991) mention that: "These values are equivalent to a total life time exposure of between 5 and 100 years in museum lighting conditions. In the extreme case of a window display exposed to daylight these figures may be reached in a few weeks" (16).

More recent researches proved that, comprising incandescent and fluorescent lamps on more than 100 commercial fabrics, it required nearly ten times that exposure in order to see some perceptible fading. That's why there is a big improvement in the dyes to the light-fastness and fading of the merchandise on display it was before (IESNA, 1986).

Consequently, the risk of fading must be considered for the lighting merchandising areas. The products in display shelves or shop windows can be changed or transferred to other shelves within some periods in order to reduce the effect of light. In addition, the use of UV filters is effective towards the fading of the products. It must be stressed that, the reduction of both illuminance and time of exposure are important in limiting any possible harmful effect of light on very light sensitive materials.

4. LIGHTING OF SHOP WINDOWS

It is a long known fact that there is a big competition between the shops in order to attract more attention and create a favorable impression for the customers who are the juries. Shop windows are the most important parts of the merchandising areas and they have to be considered when the lighting decisions are made since they contribute the visual communication between the shopper and the merchant: they represent the image and the identity of the selling environment and convey an idea about the level of prices, products and the service given. Without any doubt, shop window is the place that initiates the first opinion about the type of the products available and the style of the shop. Moreover it offers people a chance to see the merchandise not only in daytime but also when all the stores are closed.

Investigations has shown that a typical shopper spends seven seconds to cross in front of a shop window on foot, whereas by a motor car it takes three seconds or less (Parnes, 1948). It is obvious that within these limited time shop windows must use its possible advantages with materials, lighting, color scheme and a powerful design to draw all possible attention in order to be dominant in this selling competition. Green (1986) indicates that: "If the front is properly designed, one quick look will tell the shopper if the store's philosophy is in his interest" (59).

According to Leahy, what an effective shop window can do to a store is summarized as follows:

> -Sell goods
> -Stimulate demand for goods people would not otherwise desire
> -Sell the public on the values offered by the store.
> -Increase public respect for the value of the store to the community
> -Reflect prestige.
> -Educate the public to new styles, and also the new uses of merchandise
> -Tell the public where merchandise that has been advertised can be bought (quoted in Lewis, 1945: 151).

Many analyses have shown that shop window is totally responsible for one-third of the store's sales. According to the results of the surveys made, people buy goods just because their attention has directed solely towards the merchandise on display (Parnes, 1948).

One of the surveys, seen in Figure 4.1., which was done in a large metropolitan department store, showed that people buy because the merchandise on display catch their attention even though they do not have the buying decision in their minds (Lewis, 1945). Similar investigations asserted that regarding the customer's attraction values, announcements done by publications as newspaper advertising has less effect than the shop windows (Parnes, 1948).

A CONSUMER SURVEY ON IMPULSE BUYING

1 DID YOU BUT ANYTHING YOU HAD NOT PLANNED?
62.3 % SAID YES!

2 WHAT PERCENTAGE OF TOTAL PURCHASES WAS MADE ON IMPULSE?
42.17 % OFF ALL PURCHASES WERE BOUGHT ON IMPULSE!

3 WHAT INFLUENCED YOU TO MAKE THESE ADDITIONAL PURCHASES?

DISPLAY	REMINDER	PRICE
75.10 %	20.0 %	11.8 %

6 OUT OF 10 WOMEN BUY ON IMPULSE
4 OUT OF 10 ITEMS BOUGHT ARE IMPULSE ITEMS
3 OUT OF 4 WOMEN GAVE AS THEIR REASON FOR MAKING ADDITIONAL PURCHASES, "I SAW IT- IT WAS ON DISPLAY."

Figure 4.1. Buying Survey Made by E.I. Dupond de Numours & Co., Inc. (Parnes, 1948, p.160).

In this chapter, regarding the growing importance of shop windows as a vital part of the merchandising areas in shops, lighting requirements are examined. The types of windows which are grouped as enclosed and open back are determined in the first part. Afterwards veiling reflections are defined, which is one of the troublesome problem and often occurs and obscures merchandise on display; the customer see the traffic or the buildings around instead of the merchandise intended to be shown. The reasons behind this problem and the necessary precautions are mentioned (with accompanying figures) in detail. In the last part, artificial lighting considerations for the shop windows are determined.

4.1. Types and Sizes of Shop Windows

As previously stated, shop windows provide the communication between the customer's expectations (outside) and the goods available inside. They are grouped as two different types according to the existence of their backgrounds or not: open back and enclosed windows. Both types have advantages and disadvantages but what does not change, is the glass that is used to protect displayed products from the external conditions and enables visibility of the goods inside to the potential customer.

Closed Back Windows: They have a wall or a visual barrier at the back which creates a very well defined space like a stage which is open to all kinds of imagination and enhance the appearance of the merchandise in it. Concentration to the merchandise is easier in closed back windows but they do not necessarily invite customers to enter inside the store.

Open Back Windows: The open one may not contribute a concentrated look on a specific product, the eye may first perceive the shop as a whole from the outside; since no background exists, the total store interior, its atmosphere and the display systems become a shop window itself. However, this type can be considered as more inviting and awoke curiosity from the overall appearance of the displays or interior atmosphere to enter and investigate more. In addition, visibility of the other people shopping inside creates an enormous positive attraction on potential customer. On the other hand, people who are inside may face with the back side of the mannequins and displays. Examples of both enclosed and open back windows are seen in Figure 4.2 and 4.3. with the appropriate lighting conditions.

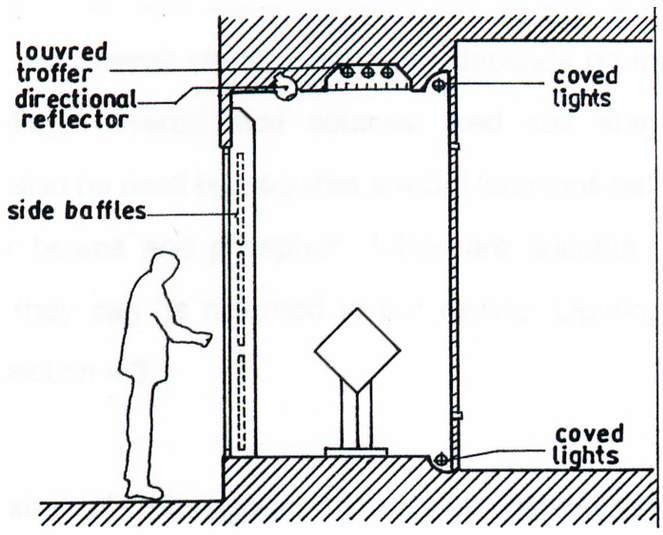


Figure 4.2. Lighting For Enclosed Display Window

(Mun, 1981, p.124).

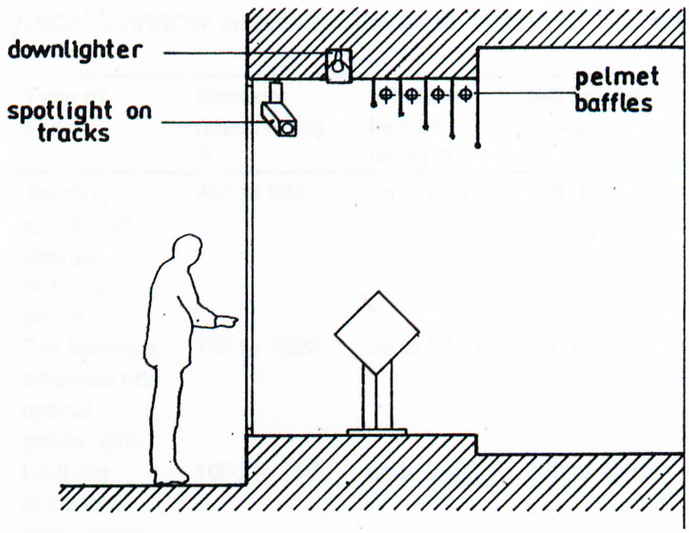


Figure 4.3. Lighting For Open Display Window

(Mun, 1981, p.124).

And other disadvantage of an open back window is the difficulty to conceal the light sources from both sides of the window as they are open to sight. Nevertheless, the overall effect is generally depends on the light coming from the ceiling, covered side sources, and self standing sources. Footlightings also be used but requires special locations below the viewing angles. Laser beams and phosphor tubes are suitable for open back windows as they can be mounted to the ceiling. Lighting methods are examined in section 4.3.

Types and size of the goods on display determines the window dimensions. Generally they are between 1.5 and 2.5 meter in depth, glazed to the floor, with a raised window bed and stallboard. Table 4.1 and Figure 4.4. shows typical window sizes for various types of shops.

Table 4.1. Typical Window Sizes for Various Types of Stores

View point	Type of shop	Window depth (mm) A	Window height (mm) B	Sill height (mm) C	Length
Very close	Jewelry, spectacles, stamps, pictures, books	450 to 950	up to 850	750 900	Varies; small windows are accepted in exclusive shops
Close	Toy,footwear, electrical and optical goods, gifts	750 to 1500	up to 2100	450 to750	Varies according to the frontage dimension
Medium	Clothing, china and glass, sport equipment, household appliances	1000 to 2500	up to 2400	300 to 450	Varies according to the frontage dimension
Distant	Furniture, floor coverings, cycles, motor vehicles	2000 to 3200	As ceiling height	0 to 100	Wide frontages may be subdivided

(Mun, 1981, p.95).

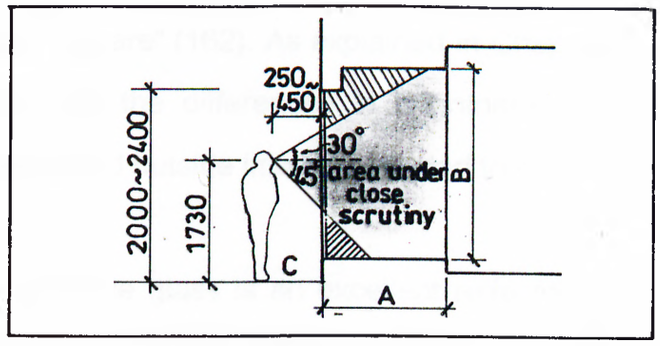


Figure 4.4. Window Dimensions (letters refer to Table 4.1) (Mun, 1981, p.95).

Referring to Table 4.1., large goods like furniture require a minimum depth of about 3.00 meter which includes provision for handling space whereas small ones requiring close inspection need 0.45 m. (Mun, 1981).

Accessibility is the other factor since the size of the window must permit easy and quick changes if they are on sale as well. Enclosed and/or glazed window back may create difficulty when the merchandise is rearranged. Nevertheless, adequate space has to be left in order to make maneuver.

The types and the sizes of the shop windows have already been mentioned. Each type may require special lighting organization but there are general principles. Apart from artificial lighting, sky brightness is totally responsible for the visibility of the window. In the following part, control of such effects from different points of view are to be stated.

4.2. General Methods Used to Reduce Glare in Shop Windows

The goods shown in the window have to be clearly visible all the time. Ketchum (1954) indicates that: "The greatest daytime enemy of shop

window visibility is glare" (162). As explained in Chapter 2, veiling glare is directly related with the differences in brightness between the display inside the window and outside images reflected through the pane.

The surface of a plate glass is an excellent reflector. It is a long known physical fact that a glass pane reflects in front of a dark background, but not in front of the bright one. While lighting one surface more than the other, the glass surface which receives the higher level of illumination has the reflective qualities of the mirror. If the interior of a shop window receives insufficient light, plate glass surface turns into a mirror and brighter objects, buildings or people on the opposite street will be reflected in the shop window pane. On the other hand, if reverse is true - merchandise is brighter than the reflected images of the outside items- the visibility becomes perfect.

There are various ways to reduce this inevitable effect of daylight. These are: increasing the brightness level inside the window, using different treatments of the glass pane, and using canopies and blinds.

4.2.1. Increase in the Brightness Level

First requirement to avoid the occurrence of these veiling reflections is the provision of a light level in the window interior which enables the goods to be seen so that external sources do not prevent visibility. Sorcar (1987) states that:

> A false concept is held by many that to do so the light level inside the show window must be equal to or greater than that outside. The designer must note that the competition is between the brightness of the displayed

> merchandise and the external reflected images on the glass (not with the brightness of the external articles) (225).

Sorcar (1987) says that according to the results of the experiments, the photometric brightness of the reflected image is approximately 10 percent of that outside. If the weather is sunny, the average brightness of the outside is nearly 3500 candela/m2, thus the reflected image brightness is 350 candela/m2. If the weather is cloudy it is nearly 140 candela/m2 or less. With respect to this explanation in order to create an optimum visibility of the displays, the photometric brightness should be equal to or larger than 350 candela/m2 if it is a sunny day. Therefore the average reflection of the article, say, 40 percent the illuminance level inside should be at least 350/0.4= 875 lux .

According to this explanation, we have to note that the type and quality of the products' material that is to be displayed in the shop window affects the apparent brightness of the window, as the reflectance factors of each material is varied. For example black velvet has a reflection factor of 0.5 percent whereas for polished silver, this ratio is 86 percent. Thus, it is possible to understand that color and texture of the materials are two determining factors for the reflectance values of the materials. Reflection values of some materials are stated in section 2.1.2., Table 2.3.

Illumination values required for the shop windows are approximately from 5.000 to 10.000 lux or even more. At night 2.500-5.000 lux are sufficient to illuminate a shop window (Parnes, 1948). It was found that an increase in brightness for the shop windows from 150 lux to 1.000 lux resulted in 70 percent more people stopping to look at the windows (Westwood, 1937).

General lighting level of the neighborhood buildings or adjacent shop windows are highly effective while obtaining the illumination level of a shop window. There is a direct relationship between the place where the shop is situated whether in a shopping center or a side street, and the brightness inside the window since the shop has to compete with the surrounding ones and must be visually attractive.

Consequently, the brightness of a shop window depends both on the reflection factors of background and merchandise, and the illumination value provided to the window.

4.2.2. Different Treatments of Glass

Except for increasing the illumiantion level inside the window, clear and comfortable perception of the merchandise on display can be achieved by using different treatments of the shop window glass. Although various ways and forms are possible in order to locate the glass on the window, in fact the basic principles are the same for all.

Since the glass pane is a good reflector, the rays which are reflected from the pane could enter customer's eye and distract the appearance of the articles. In order to reduce this effect, depending on how the glass is treated matt, black painted soffit or pavement surfaces are required so that the light could be absorbed and reflectances are diminished.

Apart from the vertical one, the window glass can be tilted forwards, or backwards. The point which has to be stressed is to find out the appropriate slope of the glass pane. For this reason, as showing in the Figure 4.5., two rays must be considered from the base (A_2) of the window which are directed to the eye of the viewer (E) and to the edge of the soffit

(F). Necessary slope of the glass must be 90 degrees to the bisector of the angle EA_2F. In Figure 4.5. the glass tilted backwards has two slopes; if not there will no space left for the display of the merchandise.

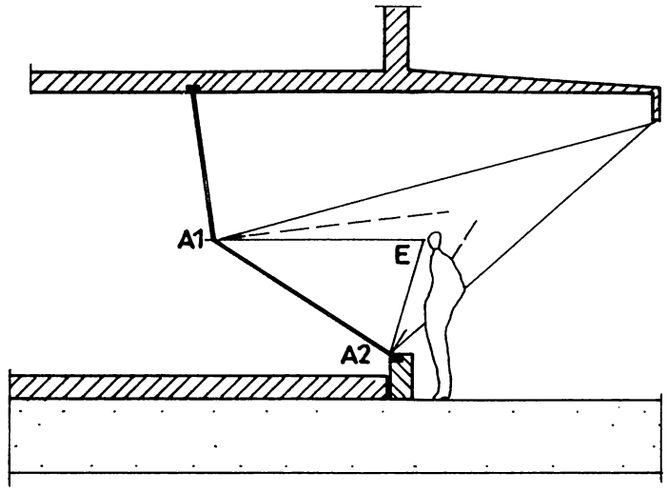


Figure 4.5. Glass Tilted Backwards Having Two Flat Panes (Turner, 1967, p.5-39).

Figure 4.6. is an example of glass tilted forwards. As can be seen, the light is directed downwards from the eye of the viewer to a dark, absorbent material. As in the previous one, the slope must be 90 degrees to the bisector of FA_1E (FA_2E).

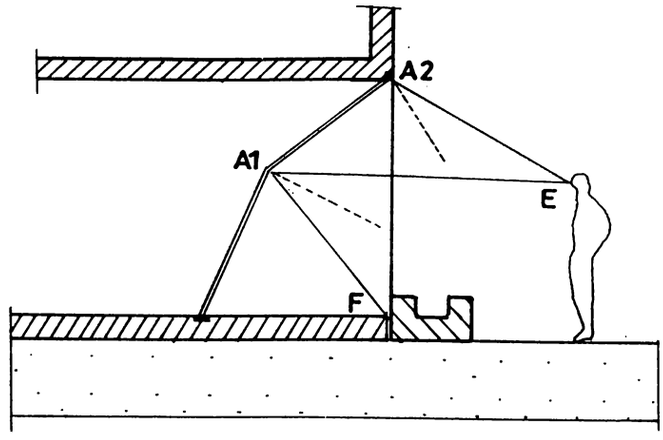


Figure 4.6. Glass Tilted Forwards

As can be seen in Figure 4.7., the curve of the window glass is composed of a parabola with a horizontal axis and focus at F, and an ellipse with foci at E and F. The light rays coming to the parabola are reflected upwards to the soffit away from the eye (parabola reflects light parallel to each other in one direction). Light ray passing from point E (that is one focal of the ellipse and at the same time eye of the viewer) will make several reflections and then will direct towards the soffit, that is to the other focal point. Thus the curve will eliminate the obscuring reflections and the glass pane will seem like invisible, as if there is no glass between the interior and the exterior. Unlike glasses curved in section, curves in plan are not suggested to be used since it collects all the reflections from several directions.

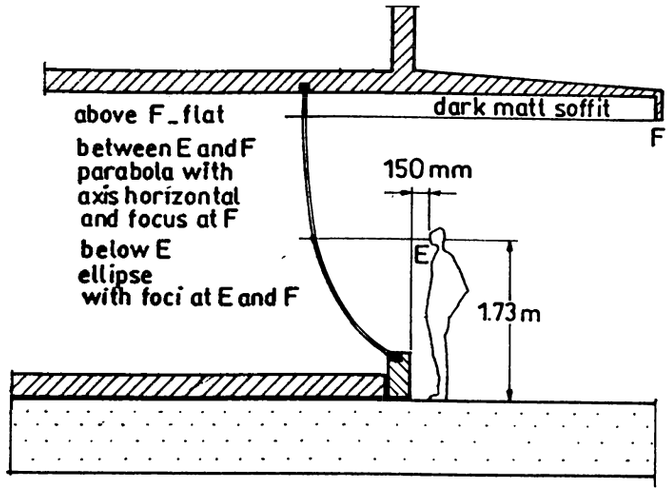


Figure 4.7. Curved Glass

(Turner, 1967, p.5-39).

One thing must be noted that, the eye level has to be taken into account according to tall pedestrian, as 1.73 meter. Considering curved or different tilted glasses, if the edge of the canopy is seen at the bottom part of the window pane, that means the slope is obtained correctly. The glass that is used in the tilted windows must be thicker than the one that is used for the vertical glass so that it could resists the bending pressure. It must be added that, curved glass is rather expensive than the vertical glass.

The role of tilting the glass for the avoidance of veiling reflections is obvious. Apart from that, there can be different locations of shop windows where still the daylight could affect the comfortable seeing of the merchandise by the customer who could have different observation points. In the following example in Figure 4.8., the window is located oblique position to the building. In the sketches, showing the plan view of shop windows, (A) represents the areas where glare occurs, whereas (B) is the glare free part of the window. In the first two sketches, the appearance of

the merchandise is obscured. In the third one, least glare occurs but the position of the customer does not allow him to see the merchandise on display.

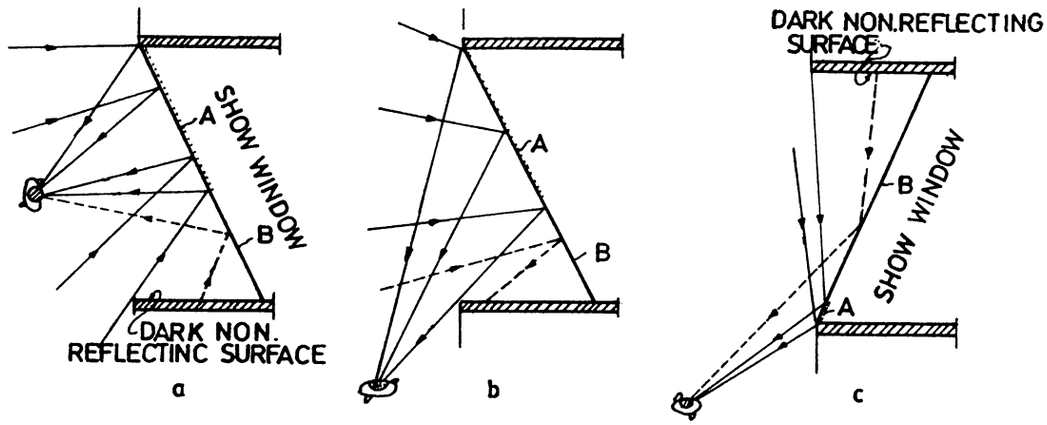


Figure 4.8. The Location of Shop Window Panes in Oblique Position To the Building

(Parnes, 1948, p.171).

Typical curved corners as shown in Figure 4.9. are mostly seen in many stores' windows. Although it seems inviting, lots of reflections are coming from all around; thus the customer sees the moving traffic or buildings instead of the merchandise.

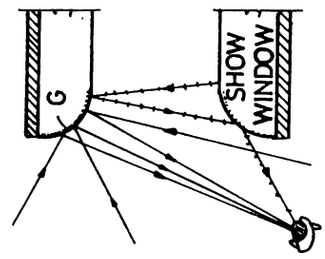


Figure 4.9. Curved Corners

(Parnes, L., 1948, p.171).

From the daylight entrance point of view, back of the shop window gets less light than the front side which is closer to the window glass. Thus, as the distance of the merchandise from the glass increases, less light will reach and there will be less brightness, thus it will be difficult to draw customer's attention to the merchandise. Figure 4.10. shows the daylight entrances to the store. Consequently, since there will be less natural light and less brightness, the backwards of the shop window must be illuminated sufficiently by artificial light sources so that the merchandise on display could be seen and attract attention.

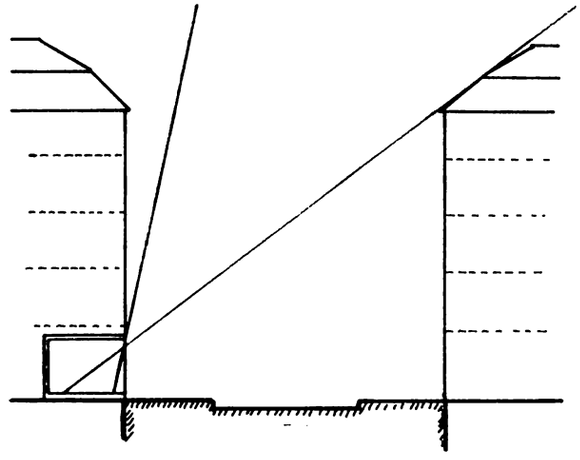


Figure 4.10. Access of Daylight into Shop Window (Parnes, 1948, p.171).

4.2.3. Canopies and Blinds

In order to control daylight and omit unwanted reflections, canopies or blinds are helpful tools as it is obvious from the former sketches. When the canopies are used, they cast a shadow on the window and make the goods visible in the window. This is the cheapest method among all other treatments of glass, and dark ones can be used as the light absorbing

material especially when they are used together with different arrangements of glass front as explained before.

As one side of the window is exposed to solar all day, some form of solar control is necessary both to prevent glare and the damaging effects of UV rays to the goods inside the window. In this respect, heat may increase in shop windows and artificial lighting reinforces this situation as well, especially for the enclosed shop windows. If the solar rays are not controlled, merchandise will be damaged by fading. This is the inevitable effect of daylight to the shop window and protection from the sun is possible by using canopies or blinds which are located at the top of the shop windows so that they could shade the store front, decrease the heat level and eliminate the effects of glare. Parnes (1948) states that by using canopy on top of the window, the reflection factor of the shaded sideway may be diminished by about 30 per cent.

Last but not the least, except from the controlling capabilities, canopies and blinds are used to protect people against bad weather conditions and also have decorative and advertising potential.

4.3. Lighting Systems in Shop Windows

It is used to be a common intention to display a series of products within the shop window and light it as bright as possible in order to show what's on sale. Nowadays, designers and the merchants are seeking to create more imaginative scenes which remind shop window's presence to the customers, treating it as a stage both in arrangement and lighting.

Basic requirements for the lighting of shop interior are valid for the shop windows as well: a flexible lighting system, shielded light sources, brightly lit merchandise against a contrasting background.

Although there are common rules or requirements in order to light a place or an environment, what differs in the lighting system of merchandising areas than an exhibition lighting is that merchandise on display changes so often. There are continuos changes in the retail environment such as: everyday changes, seasonal and promotional changes. If a color filter is permanently mounted in order to influence the coloration of a particular display, when the display is changed the color filter would remain. Chosen lighting system should allow rearrangements of extra light sources either by adding or subtracting. This point has to be stressed out while the lighting decision is given.

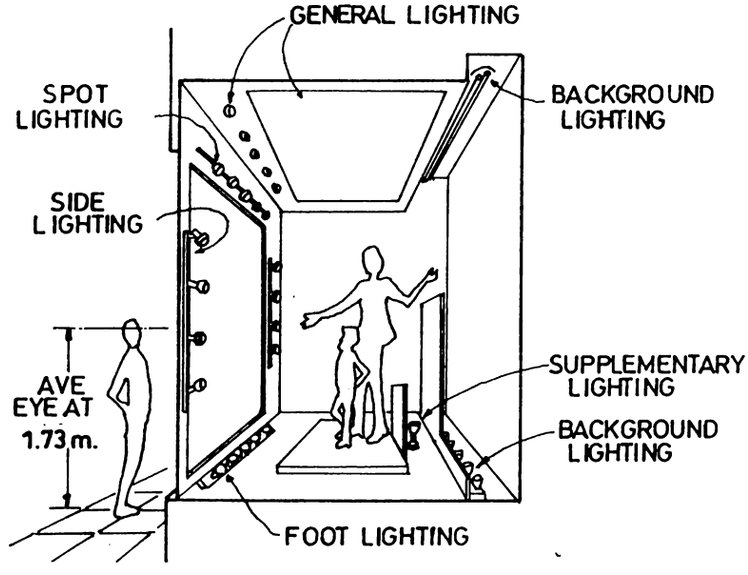
Generally speaking, flexibility offers a range of different kinds of abilities as adjustability, adaptability and accessibility. From the lighting point of view, what is meant by the flexibility is stated in Steffy's (1990) words as:

> -All luminaries (or many luminaries) are easily moved.
> -No matter how furniture gets moved around, the lighting quantities and qualities are to remain the same.
> -As tasks change or furniture moves, lighting quantities are to be changed without physically moving the lighting equipment (24).

Depending on the merchandise itself, sometimes two or three spotlights could be used and leave the rest in darkness; then one month later, it must be possible to add extra sources to create another effect. Plug-in outlets may also provide flexible lighting changes which are placed in the ceiling,

floors, and walls of shop window. A number of circuits and dimming controls can be useful in order to achieve flexibility. For applying supplementary lighting units and other electric devices, outlets in floors and walls are suggested to be used for making ready connections. Therefore, lighting system inside the window must be flexible enough to allow the layouts to be rearranged and fittings changed in order to meet display requirements.

Shop windows are usually lit by placing the lamps on the upper part of the window so that light could be distributed towards the merchandise considering the fact that people do not look up at an angle of more than 45 degrees. Show windows can also be illuminated by placing the light sources on the window bed and behind the window frame vertically if it is a closed back window: otherwise an excessive glare may occur inside the store. Figure 4.11. is shows a typical shop window with various lighting methods.



.**Figure 4.11.** Various Lighting Systems Inside the Shop Window (Sorcar, 1987, p.226).

According to Figure 4.11. lighting system inside the window is composed of: general lighting, spot lighting, foot lighting, background lighting, and supplementary lighting.

General Lighting: For some cases, general illumination could be necessary. The lamps chosen can be incandescent, fluorescent, or HID. However, if the interior is bright enough the reflectances of the other sources can act as a general lighting. The sources must be placed so that there must be no direct glare: they have to be screened above a louvered ceiling.

Fluorescent lighting is mostly preferred for the general lighting in the window. They are preferred because of having less radiant heat and being very economical in addition to a proper color rendering. Since the fluorescent window lighting is highly diffused, it is suggested to use them together with spotlighting.

Side Lighting: This type of lighting is mostly used to provide special effects. Incandescent spot and flood lights can be mounted on vertical tracks. Different types of dramatic effects can be provided by the play of light and shade or using colored lights. For creating a more dramatic effect, red or pink from one side, and blue and green from the other can be one possibility.

An example for side lighting is shown in Figure 4.12. In this case, iron stands holds several spotlights and floodlight units at various heights that are directed upon the figures, enhancing modeling effect by using stronger illumination on one side than the other. If required, an overall dramatic

effect is obtained by using colored light to the background that makes contrast with the display.

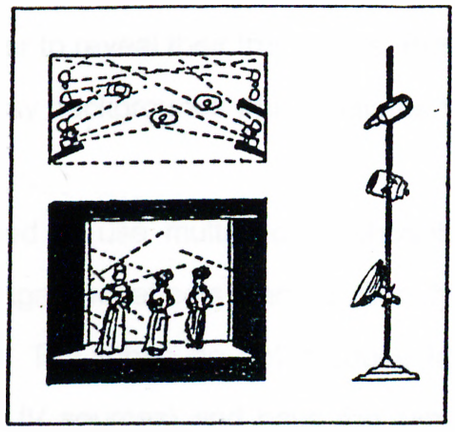


Figure 4.12. Side Lighting.

(Cox, 1952, p.106).

Particularly for the jewelry shops, in order to provide sparkle on the product on display, miniature reflector spot lights are often mounted at the sides of the window. Utilization of very well screened fluorescent tubes mounted vertically at the sides are also very common.

Background Lighting: Illumination of backgrounds is highly advisable since what enhances the merchandise appearance is the background itself. It can be illuminated by the luminaries both from the ceiling and the floor. What important is to hide them with baffles, louvers as such or place them behind a large merchandise item.

It is possible to create different effects like sunrise, sunset, snow that are projected at the background of the merchandise and change them whenever the merchandise is replaced. To contribute an atmosphere like that is available just by placing the slide of that particular effect at the

center of a 10x10 cm steel mat and this could be held in front of the light fixture for projection (Sorcar, 1987).

For the illumination of the merchandise in the window, white light is recommended in order to reveal their true colors. But colored light is highly valuable for the display backgrounds which initiates the first impression.

It could be suggested to use multicolored phosphor tubes in order to create different background effects and to identify the space where a product is displayed. The tubes do not produce light (but glow brilliant colors when lit with UV sources) and have the similar effects with neon. The tubes which have the diameter of 2 to 12 mm, are covered with phosphor and it is easy to form to the tubes according to the desired shapes.

Footlights: This type of lighting is very useful to eliminate the unwanted shadows which are created by the general lighting or the spotlights used on the ceiling. Unidirectional fluorescence or a row of incandescent lamps can be mounted on the floor.

Spotlighting: They produce highly concentrated illumination that are used to accentuate the appearance of the objects and help to increase their visual value. It is possible to place them both one by one to the ceiling and on a track. Spot lights are essential in order to make emphasis and can be fitted with simple baffles to prevent glare.

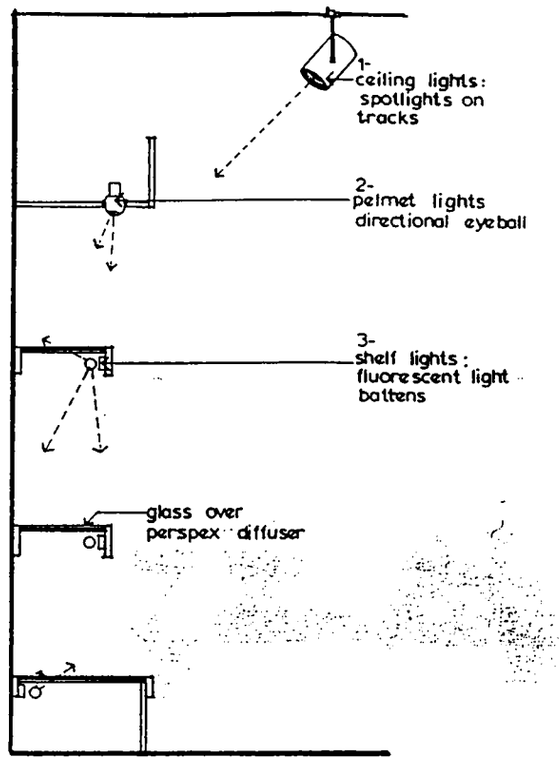


Figure 4.13. Methods of Lighting a Showcase Unit

(Mun, 1981, p.124).

Sometimes kinds of products like jewelry or confections are chosen to be displayed on shelves mounted very close to the window glass. Supplying a lighting system which illuminates only from the top is difficult and may not be enough. It could be more effective by placing extra lamps under the shelves when used miniature fluorescent tubes (Cayles, 1983).

Consequently, for the flexibility and desired appearance, a system of adjustable flood and spotlights are needed. Moreover, equipments such as simple reflectorized lamps with adjustable lamp holder which are used to illuminate feature displays in interiors or some stage lighting units can be applied for shop window lighting. There always have to be two or more adjustable units to create different modeling effects constituting shadows,

colored shadows or accent merchandise having brightness differences and sparkling highlights. In recent times, laser beams take their place in the shop window scene. As it is difficult to conceal the light sources from both sides of the window in an open type one, they could be appropriate since they can be mounted on the ceiling.

Shop windows can be considered as a stage for displaying merchandise. The actors are the goods and the audience is the customers. As Cox (1952) states that: "The store window is a stage on which the merchant presents at least the first act of his drama. It should arrest attention at a flash glance, yet the attention getting device should never distract from the main purpose of showing merchandise" (105).

5. LIGHTING OF INTERIORS

As Barr and Broudy (1990) explain, an appropriate lighting design is essential for the merchandising areas when compared with the lighting of other areas, since the visibility of the products and their desired appearance directly influence the sales rates. He states that: "Architectural programs for other types of building programs place lighting further down on the design decision-making list. But a retail space virtually lives and breathes by the success of its lighting plan. It is a prime factor from the inception of the design process" (Barr and Broudy, 1990: 66).

The purpose of interior lighting of the shops is summarized by Mun (1981) as follows:

> -To show the goods on display as clearly and attractively as possible in a way that attracts customers' attention.
> -To employ color in a manner that suits and comprehends the display.
> -To be flexible enough to accommodate changes in display or layout.
> -To use the correct illumination level for each task and avoid the uneconomical use of electricity.
> -To avoid glare (122).

Artificial light is mostly preferred than the natural light in merchandising areas. As it is known, the control of the daylight creates problems because of the changing brightness of the daylight according to the time of the day and to the seasons. According to Green (1986): "Retail stores are similar

to legitimate theaters in their lighting needs: both require precise lighting control to dramatize the environment. This control is most easily attained by excluding natural light, rather than by attempting to modulate it" (119). On the other hand, it is easier to control the intensity, direction and the color of an artificial light (Ketchum, 1954). Therefore, the effects of daylight to the store window is examined in section 4.2., however, concern of this chapter is only the artificial lighting for the merchandising areas.

This chapter is composed of two main parts: shop profile and the lighting plan. In the first part, according to the price levels and the expected image, the shop profile is defined. In order to achieve the suitable lighting plan, "the four corner philosophy" developed by Philips which unites the shop profile with the possible lighting conditions comprising lighting levels, lighting sources are determined. The lighting plan which is composed of the selection of appropriate light sources, lighting fixtures and lighting methods are stated in the second part in detail.

5.1. Shop Profile

Since there is a variety of stores in the retail world, each selling different articles ranging from vegetables to precious stones, the determined character of the store interior and the price labels shown in the shop window give an idea about the kind of products sold and the service given.

The goods on sale and the consumer groups which are aimed to be reached are two determinant factors for the character of the store that is wanted to be created. The more the customer is satisfied, the higher is the sales rate. As it is stated in the third chapter, the lighting system of the

merchandising areas is the best tool to contribute the image to be reflected. It is mentioned in the International Lighting Review (1985) that:

> It is very difficult to give precise guidance on exactly what constitutes the proper lighting for a particular class of shop, for there are no doubt many expectations to the rule-of-thumb approach . . . But were some guidance nevertheless to be attempted, then the division of lighting according to the price class would appear something like that given in table 5.1. (56).

Table 5.1. Very General Division of Shops According to Price-Class

	SALES General	FLOOR lighting	levels (lux)			DISPLAYS
price-class	**sales area counters**	**counters cash-desks**	**gang-ways**	**lighting system**	**lighting level**	**sales aid**
very cheap	500	to	700	bare fluorescent luminaires HID downlighter		from very simple and functional racks and shelves
cheap, but value for money	300 to	500	200	reasonably-well screened fluorescent luminaires. HID downlighter	ca. 2.500	
quality without the frills	100**	450		well-screened fluorescent luminaires incandes-cents, HID downlighter	to	to
quality/style	*	300	**	decorative low-brightness fluorescent and incandes-cent luminaires		
selected high-quality	*		***	sophisticated (gold) incandescent reflector lamps, fluorescent luminaires		
exclusive				general lighting with sparkle given by, say, chandeliers**	20.000	stylish furniture and tableaux

* = solely with display lighting

**= contribution from display lighting

***= solely with stray light from display lighting

(International Lighting Review, 1985, p.56).

According to the Philips Lighting Handbook (1993), International Lighting Review (1985) and Roush (1994), the first thing to be decided before arranging the lighting system is the shop profile in order to present to the customer. Referring them, shop profile is composed of four parameters as: price class (expensive or inexpensive), shop image (from exclusive to simple), article range (wide or narrow selection) and sales style (personal or impersonal). The parameters are explained in Table 5.2.

Table 5.2. Shop Profile

	Shopping behavior and client needs	Presentation
Price class	Inexpensive	"Low budget" image
Shop image	Weekly purchases	Mass presentation
Article range	Wide	Broad target group
Sales style	No need for service	Self-service
Price class	Low	"Value-for-money" image
Shop image	Daily Purchased	Simple presentation
Article range	Limited	Neighborhood/community target group
Sales style	Need for service	Service as social contact
Price class	High	"Quality" image
Shop image	"Impulse buying"	Refined presentation
Article range	Wide range of high-quality articles	Broad, quality -conscious target group
Sales style	Service required	"Shopping is Fun"
Price class	Expensive	"Exclusiveness"
Shop image	Deliberate purchases	Exclusive presentation and ambiance
Article range	Exclusive	Small exclusive target group
Sales style	Need for individual service	High-level personal service

(Philips Lighting, 1993, p.229).

The parameters are placed at the four corners of the matrix diagram as shown in Figure 5.1. which is so-called four corner approach to shop lighting design. It is possible to find the representation of all types of stores in the diagram. For example, we can place a grocery in (A), ice cream parlor in (B), a department store in (C), and a fashion shop or a jeweler in (D). Figure 5.2. shows several types of merchandising areas in a diagram.

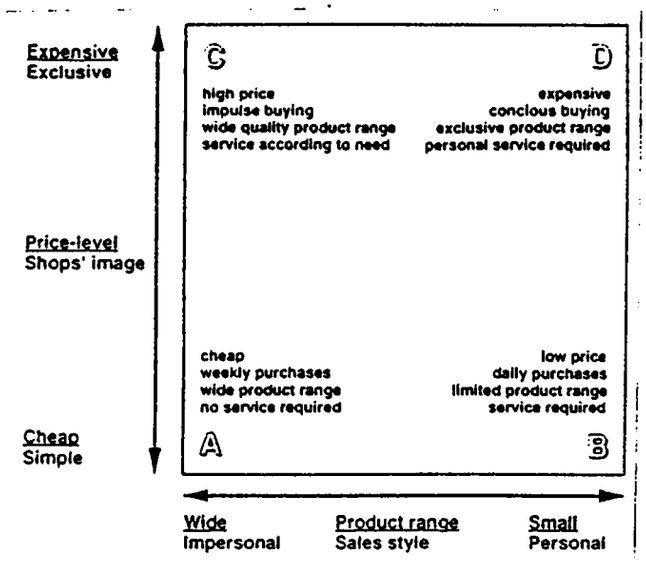


Figure 5.1. The Shop-Type Diagram, or Matrix, Used in the Four Corner Philosophy.

(Roush, 1994, p.28).

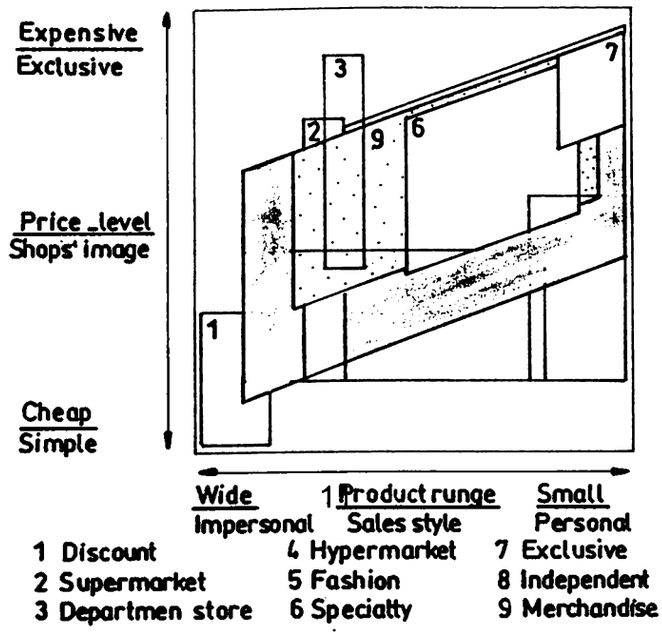


Figure 5.2. Shop Types

(Roush, 1994, p.28).

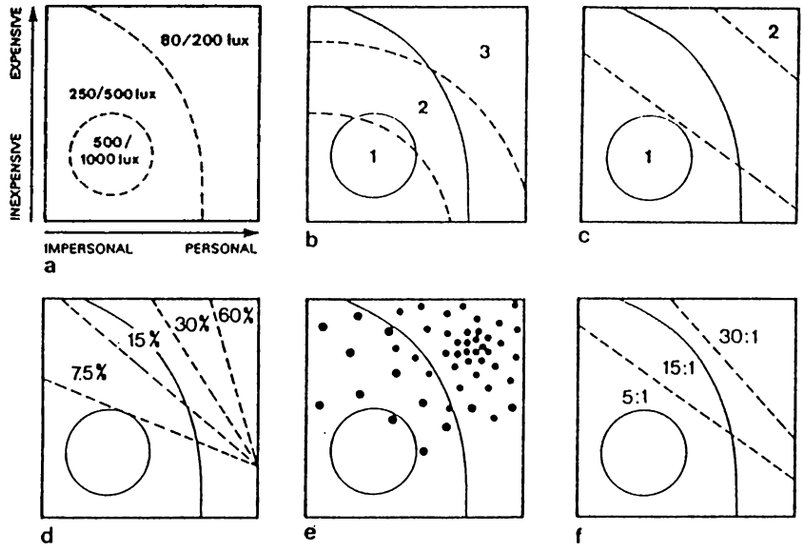


Figure 5.3. The Six Lighting Design Diagrams: a) lighting level, b) color appearance (1 neutral white 2 warm white 3 extra-warm white), c) color rendering (1 good 2 excellent), d) decorative elements, e) density of accents (small dots indicate many small accents, and larger dots stand for fewer strong accents), f) contrast value.

(Philips Lighting, 1993, p.232).

It is stated by Philips Lighting (1993) that:

> The Four-corner Philosophy is in fact a step-by-step design procedure based on the use of ready-made diagrams or templates. There are eighteen diagrams in total. Six of these (Figure 5.3.) relate to one or other aspect of lighting, and twelve (Figure 5.4. and 5.5.) are to do with the choice of the lighting hardware (lamps and luminaries) (230).

International Lighting Review (1985) explains the application of the "Four-corner Diagram" as follows:

> Having indicated the position occupied by the shop in question in the diagram of Figure 5.1., this diagram is placed, as it were, over each of the eighteen diagrams in turn and the relevant data read off . . . All the technical know-how surrounding shop lighting is contained in the diagrams, and when accessed by the user will allow a detailed lighting plan to be readily formulated (6).

After determining the exact shop profile and finding the place where the particular shop falls on the map, the selection of the light sources which are ideal for the establishment would be easier. Figure 5.4 presents the light sources for the general lighting where as Figure 5.5. shows the ones for the accent lighting.

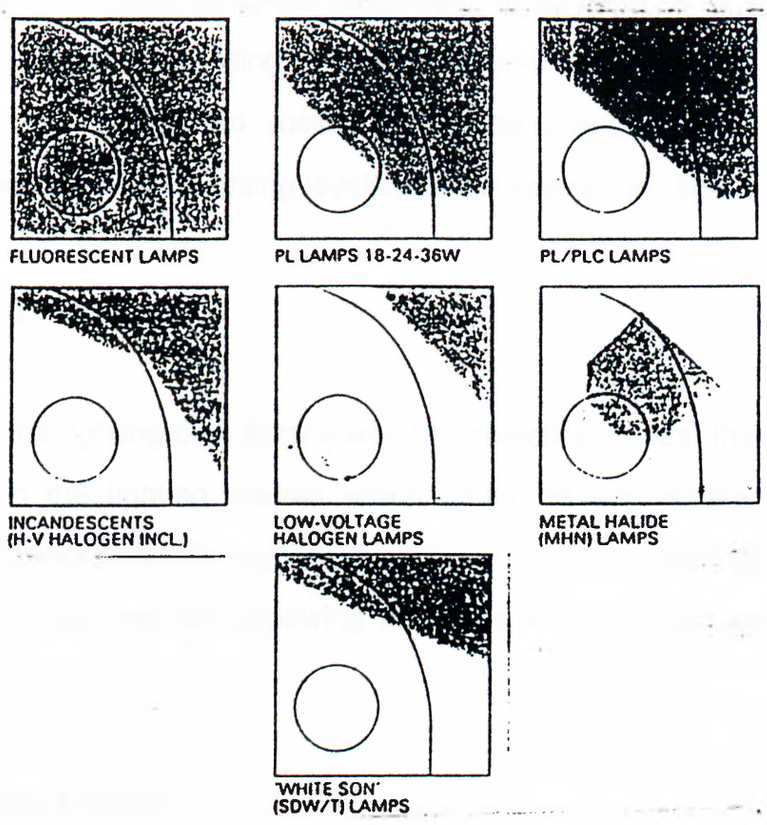


Figure 5.4. The Seven Light Selection Diagrams- General Lighting (Philips Lighting, 5 th ed. Netherlands: LIDAC, 1993, p.235).

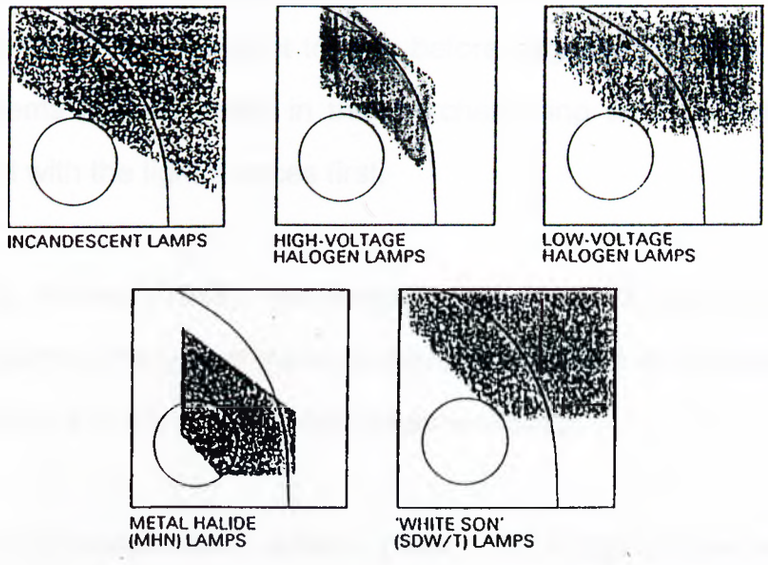


Figure 5.5. The Five Lamp Selection Diagrams - Accent Lighting (Philips Lighting, 1993, p.236).

Therefore, with the help of matrix diagram, it is possible to arrange the whole lighting system according to the price levels and the desired image which is wanted to be created. Just by placing the shop profile on the map, it would be easy to obtain lighting levels and the appropriate light sources.

5.2. Lighting Plan

Selection of the lighting plan begins with the selection of, first the lighting sources, then the lighting fixtures which could be appropriate for the environment, and since the lighting system of a retail establishment is composed of these two, the following parts are directly interrelated with each other.

5.2.1. Lighting Sources

"In the store area, the professional concept of a modern light design is initiated with the choice of appropriate light sources" (International Lighting Review, 1994: 66). With respect to this, before beginning to examine the lighting systems that are used in the merchandising areas, it would be better to deal with the light sources first.

According to Parnes (1948), the selection of the light sources mostly depends upon the; the type of trade, of merchandise and of customer, and on the importance of a true or special color rendering.

According to Woodward and Laplante, (1990: 22), a light source must be chosen so that: ". . . leaves a favorable psychological effect on the viewer, one does not dramatically change the appearance of the object, and finally

and most importantly one does not emit unacceptable levels of UV radiation" (22).

In general, it is possible to classify the light sources, which could be used in store lighting, under three main headings as: incandescent, fluorescent and H.I.D lamps. For each one, there are various lamps which differ in the construction, wattage, luminous efficiency, color properties, and price. Each one has the advantages and disadvantages of their own.

5.2.1.1. Incandescent Lighting Sources

It can be stated that color rendition of fabrics and skin tones under incandescent light are warm and flattering as they emit warm, yellow-reddish light. It is also possible to obtain concentrated points of light in the form of spots and floods, that is useful to focus attention to the merchandise on display (Parnes, 1948). This type of sources produce bright, sparkling quality of light and cast shadows which is good for accentuating the three dimensionally of the merchandise. It is also possible to control them by the dimmer switches and other electronic devices.

Incandescent light sources have different shapes and forms. They include GSL (General Service Lamps), tungsten halogen lamps, reflector lamps, and such. The following are the mostly preferred ones for the lighting of merchandising areas.

A and PS types can be considered as general service lamps. They have a range of 15 to 200 watts. They have the lowest initial cost, and have an average life of 1000 hours. The light emitted is uniform to all directions.

The envelop could be clear, pearl, silica coated and colored. While clear lamps give sparkle, pearl or silica coated ones create diffused effects (Mun, 1981 and Sorcar, 1987).

TH (Tungsten Halogen Lamp) offers a good color rendering quality that is particularly vital for displaying fabrics or cloths where color is important. Tungsten halogen lamps can be seen in two different forms as: low-wattage version (capsules and reflector lamps) and double ended mains voltage lamps.

Particularly in retailing, low-wattage tungsten halogen lamps are used in abundance to give brightness and sparkle in interiors. However, if series of low-wattage tungsten halogen lamps are used for the general lighting rather than the display lighting; since they generate more heat, they may cause local air conditioning problems.

One of the most widely used lamps are reflectorized lamps. ER (elliptical reflector), R (reflector), and PAR (parabolic aluminized reflector) lamps are produced with the built-in reflectors. Wide-beam and narrow-beam spreads are available. Wide-beam lamps, that is flood lamps are mostly preferred for general illumination and wall-washing purposes whereas spot lighting, narrow-beam, contributes concentrated light that is suitable for the display lighting.

PAR lamps can be obtained in different wattages (between 50 to 300 watts) and sizes (between 121 mm to 203 mm diameter). PAR- bulbs are made of heat resistant glass. Incandescent lamps used in the retail stores are illustrated in Figure 5.6.

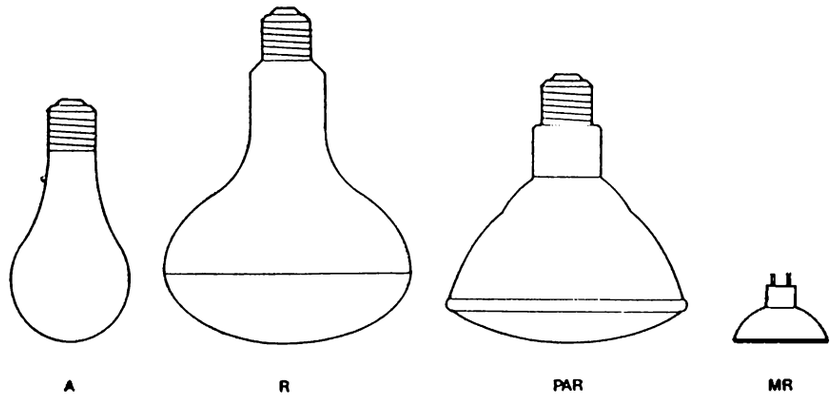


Figure 5.6. The Shapes and the Names of Incandescent Lamps Used in Retail Stores

(Green, 1986, p. 120).

In order to identify one of these lamps, or while searching the appropriate light source for the merchandising areas from the catalogs, it is necessary to know the simple code which all the lamp manufacturers use. For example, it may be written as: 25T10/ IF 120V

The first number shows the wattage, that is 25 in the example. Low-wattage bulbs are energy efficient, the heat that is emitted is low as well, and they have longer lasting life. In fact, low wattage lamps are said to be appropriate for the commercial spaces, with approximately 3.05 meter ceiling height (Grosslight, 1990). They could have one drawback, that is, the need for a bulky transformer. Though smaller ones are available, they still have to be concealed in the ceiling, or a wall: the application could be problematic especially for the small interiors.

The second one, T, identifies the bulb shape: tubular. Different forms and types of the bulbs that are usually used in retail lighting are expressed above (see Figure 5.6.).

The number next to the bulb shape is the bulb size: the measure of the diameter of the lamp which is taken from the widest point on the glass. It is expressed in eights of an inch. The example given is the tubular-shaped lamp having 10-eights of an inch, or 1 1/4 inch in diameter.

The other character is the finish of the lamp. Some finishes of the incandescent lamps are stated as: inside frost (IF); white (W); colored bulbs as red, yellow, green, and orange; clear (CL) and silver bowl lamps.

The last one is the rated voltage. It means 120 volt circuit.

If the lamp is tungsten-halogen, the identification of it is similar apart from the "Q" that is added in the beginning. So it is possible to see a code like: Q75MR16/NFL, which means a quartz, 75 watts, MR-16 incandescent type source having a narrow beam distribution (IES Education Series, 1988).

5.2.1.2. Fluorescent Light Sources

The fluorescent lamp is the best known gaseous discharge lamp, by which light is produced by the fluorescence of phosphors activated by ultraviolet energy from a mercury arc.

Unlike incandescent light, fluorescent light provides more diffused light. Because of this, shadows and the modeling effect is reduced. This could be beneficial if they are used in stock rooms or in offices. They are usually preferred for the general illumination of the merchandising areas.

The light produced radiates less heat than incandescent ones. Fluorescent lights considered as the economical light sources among all other types

and have varying color rendering properties (see table 5.3.). In fact, color rendering of fluorescent lamps depends on the kind of phosphorus that it contains.

Fluorescent light sources are good at illuminating large areas and have longer life than others. Moreover, it is possible to change the lamp easily and it offers the dimming property but that is expensive.

5.2.1.3. High Intensity Discharge (H.I.D.)

When H.I.D. lighting is considered; mercury, metal halide, and high pressure sodium sources can be stated. They are more or less similar to fluorescent lamps in operation and efficiency, and to incandescent lamps in shape and size (Green, 1986).

They might not be so suitable for the lighting of retail establishments since they are not good at color rendering property, or can be used in stores where color discrimination is not necessary. Mercury based lamps mostly preferred for the outdoor applications.

However, H.I.D. lamps can be used for the general diffuse illumination of the merchandising areas. Green (1986) indicates that:

> In open reflector-type fixtures, these lamps can give some of the appearance and modeling effect of incandescent lighting. In terms of brightness, metal halide lamps are even more efficient (85 to 115 lumens per watt) than fluorescent lamps. They may be used if the cost of lighting is a stronger factor, but should be avoided if color rendering is essential (124).

Consequently, when a light source is selected for the illumination of the retail space, the color of the merchandise, the effect that is wanted to be created must be considered. If colors like reds, yellows are to be accentuated and warm, intimate atmosphere is to be created, incandescent light sources will be the best selection. They provide glitter and sparkle in spaces where necessary. Since they emit directional and concentrated light, modeling effect occurs. Moreover, they have a low initial cost and good optical control capabilities. Nevertheless, fluorescent ones mostly preferential for general lighting, but they could be used with incandescent light sources in order to achieve a balanced diffused and directional lighting. They mostly enhance the blue, green colors of the merchandise on display. H.I.D. lamps are not highly preferential for illuminating merchandising areas because of their poor color rendering property, but depending on the situations some of them could be used. Table 5.3. summarizes the general characteristics of light sources.

Table 5.3. Electric Light Source Characteristics

Characteristic	Filament Incandescent	Fluorescent	Compact Fluorescent	High Intensity Discharge
Light Source	Medium-intensity point source of light; capable of long-range projection as a directional cone	Low-intensity linear source of light; capable of short-range projection of a directional wash	Medium-to-high intensity linear source of light; capable of medium range projection of a directional wash	High-intensity point source of light; capable of medium range projection as a directional cone, and long range projection as a general wash; new generation of halide incandescentli ke lamps will be capable of long range projections as directional cones
Luminaries size	Compact to moderately compact depending on particular lamp shape, wattage, and application	Moderately compact to bulky depending on application	Compact to moderately compact depending on application	Moderately compact to bulky depending on application
Efficiency (light efficiency)	10-25 lumens/watt	65-92l lumens/watt (includes ballast)	30 79 lumens/watt (includes ballast)	80-110 lumens/watt (includes ballast)
Effective life	750-2000 hours	15.000-20.000 hours	10.000-20.000 hours	15.000-20.000 hours
Color rendering index	Excellent	Poor to very good	Good to very good	Very poor to very good
Color Emphasized	Red, orange, yellow	Various colors depending type of the lamp	Various colors depending type of the lamp	Yellow, blue, green but new generation produces all colors

5.2.2. Lighting Fixtures

In merchandising areas, lighting fixtures can be grouped as: direct and indirect lighting fixtures. For the direct lighting fixtures, the light beam is directly concentrated on the product on display. For the other type, the light is directed towards the ceiling or a wall, then on to the object. Direct lighting can be either diffuse or directional; but indirect lighting is invariably diffuse. Types of lighting fixtures that are mostly used in retail establishments are analyzed in the following section:

5.2.2.1. Direct Lighting Fixtures

For the direct lighting sources, following could be considered: downlightings as recessed, open reflector, nonreflector and adjustable; wall washers; track lighting; and surface mounted fixtures. They are the fixtures that permit installation of more than one type of lamp.

Downlighting: Downlighting is one of the simplest and mostly used lighting fixtures among others. It is very practical in principle, as Ketchum (1954) indicates that: "Light from sources at ceiling level directed downwards to the merchandise to the inspection level and to the traffic areas in sales space" (71).

Downlightings can be suspended, surface mounted, or recessed into the ceiling. They could be adaptable, since it is possible to illuminate not only the large areas but could focus onto the merchandise itself with narrow beam spread.

Green (1986) explains recessed downlights as: ". . . are installed above the ceiling with only a small trim ring left exposed below the ceiling" (124). They are manufactured for general-service (A- and P- bulbs) and reflector incandescent lamps and for HID lamps. The light output from these fixtures is directed almost totally downward". Recessed downlighter is shown in Figure 5.7.

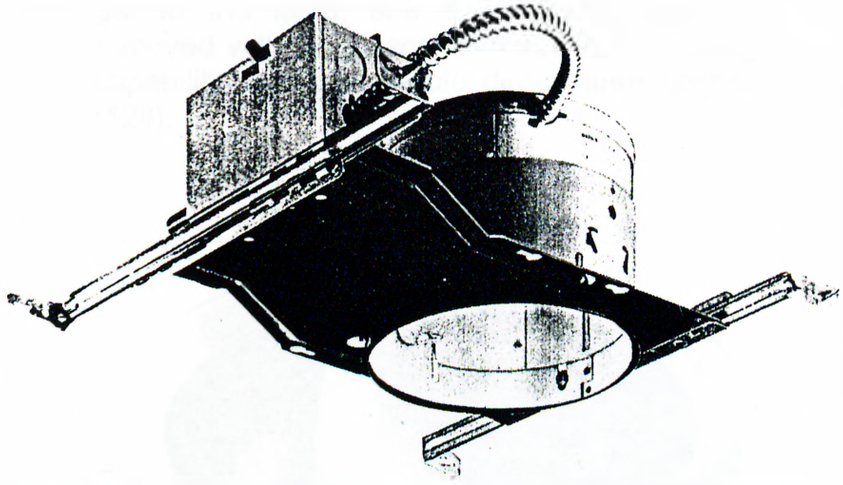


Figure 5.7. A Recessed Incandescent Downlight Housing.
(Green, 1986, p.125).

As Nuckolls (1983) mentions that the reflector serves two purposes: "It redirects (by reflection) the otherwise wasted upward component of the light source down through the aperture and distributes it in a useful pattern. The reflector may also be used to minimize the bright glare that may be visible from the at normal viewing angle" (243).

For open-reflector downlights, it is easier to replace the lamp since the aperture is open. This advantage could bring a disadvantage, that is, the reflector is not protected from the dust, dirt and the other external factors. Green (1986) also explains more about the open-reflector downlights such that:

They consists of a simple metal fixture with a socket that houses a general-service lamp or H.I.D. lamp (for H.I.D fixtures, a ballast is also provided), and a dome shaped reflector to redirect the light from the lamp. A common reflector for this type is a highly polished, dome-shaped reflector that is available in a clear or gold finish (Figure 5.8.). Open reflectors provide excellent general lighting with some modeling effect. They offer easy lamp maintenance (no parts need to be removed to get to the lamp, and the reflector can be removed with an extension pole), full dimming capability, and reasonable direct glare control (124).

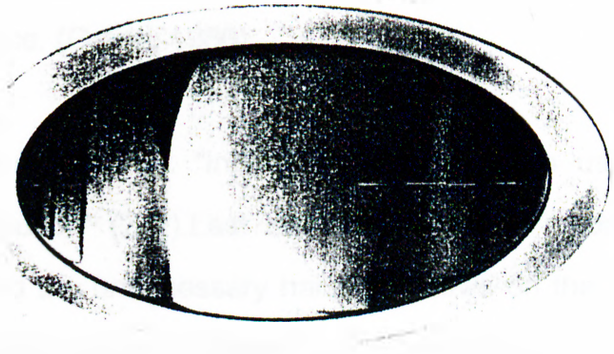


Figure 5.8. A Specular Reflector

(Green, 1986, p.125).

Downlights without reflectors or lenses are also called "cans". For this type of downlights, the lamp must have its own reflector system because that is not present in the fixture itself. Thus, R-, PAR-,or MR- bulbs are suitable for nonreflector downlights. Although they are very expensive, the reflectorized lamps that are used inside is comparatively expensive.

However, these reflectoized lamps have advantages; as they are long lived and efficient; and provide good point- source illumination especially

when they are placed in high ceilings (PAR lamps and to a lesser extend P lamps). In addition, again depending on the lamp used, they provide a higher degree of modeling effect (Nuckolls, 1983 and Green, 1986).

Adjustable downlighting fixtures have metal housing which could be wholly recessed into the ceiling (open adjustable type) or semirecessed (the "eyeball" type). The lamps which have interior reflectors are suitable for this type as R, PAR, or MR bulbs. Adjustable downlighting fixtures are very functional to illuminate the displays which are not directly below the lighting fixture. The lamp can be rotated 360 degrees and can tilt up to 35 degrees. One thing has to be noted that these lamps are expensive and it is difficult to replace. (Green, 1986).

Nuckolls, (1983) states that: "Incandescent downlights usually have a direct light distribution" (242).Last but not the least, in order to avoid reflected glare and the unnecessary harsh shadows on the merchandise, down light luminaries are to be placed close together and the light output is spread over a large area.

Wallwashers: Generally, downlights accentuates horizontal surfaces while wall washers are used to illuminate the vertical surfaces. Wall washers provide diffuse, shadowless light. Green (1986) indicates that: "Wall washers consist of a fully recessed metal housing that has a fixed socket with or without a built-in reflector. Therefore, they can house both reflector and nonreflector lamps" (127).

They are mostly placed one after the other symmetrically as a series of lamps, with equal distance from their center, about 1 m away from the wall and from each other. "Placement at greater distances will cause uneven

illumination" (Nuckolls, 1983: 252). They illuminate nearly 1.5 m down the wall.

One thing has to be noted that the specular surfaces must not be illuminated by wall washers. When a glossy surface such as polished marble, or oiled wood is lit with them, glare will occur because of the mirror image produced.

Track Lighting: One of the best and the mostly used lighting fixtures for the merchandising areas is the track lighting. Since they provide great flexibility as the direction and the location of the light source could be changed to the desired way, they are convenient to use for the retail establishments where flexibility is vitally important.

Track lighting is composed of a continuous linear electric power source and hanging system, that is the track and the luminaries as can be seen from Figure 5.9.

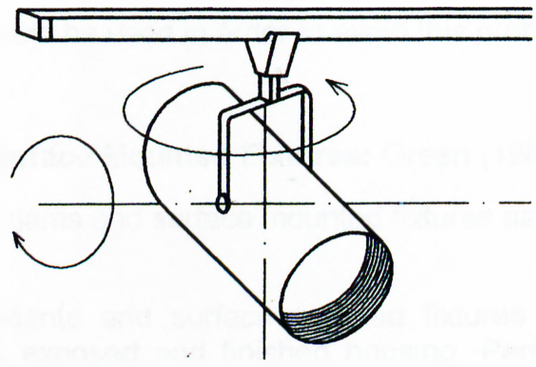


Figure 5.9. A Typical Track Lighting
(Sorcar, 1987, p.124).

Sorcar (1987) states that:

> The anodized, extruded aluminum track is an electrical raceway that supplies the power to the luminaries mounted anywhere on its entire length. The luminaries can be moved horizontally and vertically. With this mobility a track-light system offers optimum flexibility in a vast range of lighting effects. A track can be surface-mounted, pendant, or recessed in the ceiling ; the most popular is surface mounted. Pendant types are used in rooms with high ceilings; recessed types, with low ceilings or where a "clean" appearance is needed (124).

The luminaries used in the track lighting could be in different shapes, having different sizes and colors. As reflector lamps, R-, PAR-, or MR-bulbs could be used in track lighting fixtures, since there is a great variety of fixture housing. Colored filters could also be attached directly to the fixture if varied effects likely to be created.

The most important disadvantage of the track lighting is that it has a potential to create direct glare. It is because the luminaries could be placed in different directions and the light sources are to be visible by the people. Baffles could be used in order to avoid this problem.

Pendants and Surface Mounted Fixtures: Green (1986) summarizes the specialties of pendants and surface mounted fixtures as:

> Pendants and surface-mounted fixtures have fully exposed and finished housing. Pendants are suspended from ceiling on rods and are used where ceilings are high, requiring fixtures to be lower, or where ceilings are unfinished. Surface-mounted fixtures are attached directly to a ceiling or to soffit and are exposed to view. These fixtures may be used on unfinished

> ceilings or as an architectural feature. Pendants and surface-mounted fixtures have design and optical qualities similar to direct lighting, recessed and track lighting (130).

Pendants are suspended from the ceiling by a "stem", which is a narrow decorated pipe at the same time carrying the conductors to the fixture. Stems are directly connected to the ceiling through a swivel to hold the fixture that is perpendicular to the floor. The thickness of the fixture depends on the: lamps size and its mounting, and the ballast location. The ones with the horizontal lamps and the remote ballasts are slim fixtures that are hung with a single stem, giving a clear appearance. On the other hand, the pendants that have self contained ballasts and vertically operated lamp need a greater depth (Sorcar, 1987). It is possible to see the cut-away view of high-intensity discharge pendant light fixture in Figure 5.10.,.

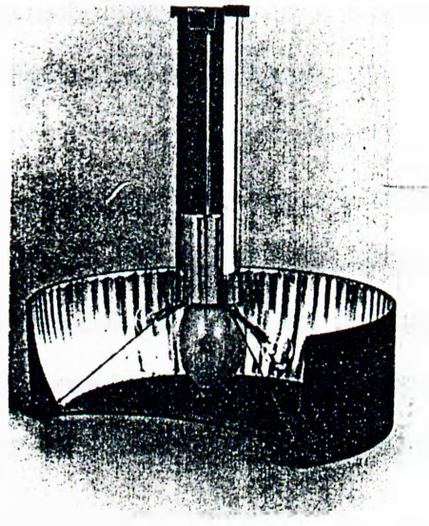


Figure 5.10. High-Intensity-Discharge Pendant Lamp Fixture (Green, 1986, p.131).

Surface mounted fixtures are generally preferred to be used when access is not available above the suspended ceiling or the ceiling does not allow to be penetrated.

5.2.2.2. Indirect Lighting Fixtures

Indirect lighting is used for having a general diffuse illumination. This is achieved by directing the light towards the ceiling: then the light is reflected below, to the merchandise or display. Since this is so, there is no modeling effect created; for this reason it is advised to use them with direct lighting fixtures. One thing has to be noted that the intense lighting level or the very high ceiling brightness must be avoided since too much ceiling brightness direct the attention away from the merchandise.

Cove and Bracket Fixtures: Cove lighting is a diffuse illumination such that, the indirect light is emitted from a continuous niche and distributed towards the ceiling. By using these fixtures, it is possible to obtain pleasing brightness level if the light is uniform enough.

These fixtures are mounted on a wall, nearly 0.40 to 1.00 meter below the ceiling. Inside them fluorescent and incandescent lamps can be used. Cove fixtures are preferential especially for the general illumination of a space. By hiding the fixtures behind a cove molding or a decorative linear box, this diffused effect is obtained. Figure 5.11. presents cove lighting.

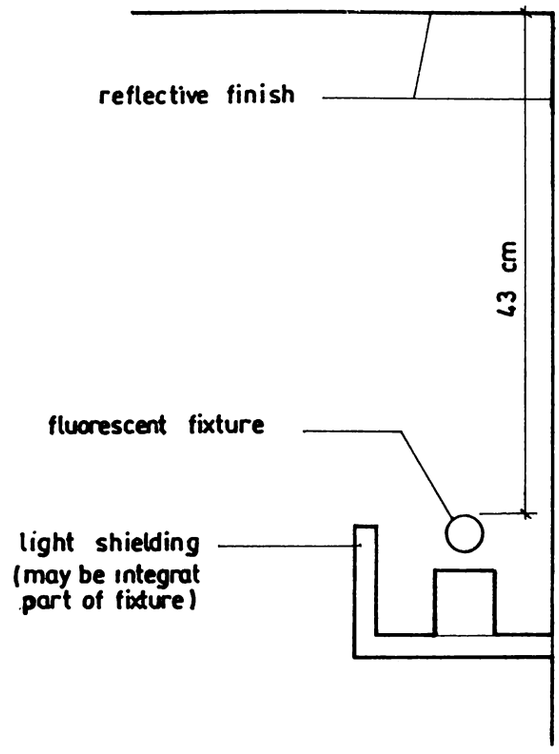


Figure 5.11. Vertical Section of a Cove Lighting Fixture for an Indirect Fluorescent Lamp
(Green, 1986, p.131).

The color, material and the texture of the space where light is reflected are determinant factors for the intensity and the quality of the light. White, non-absorbent spaces increase the reflection, whereas dark, non-reflective ones decrease the effect of light that is directed to the ceiling. If the fixture is close to the ceiling, moreover if ceiling finish is specular, it is possible to notice hot spots and unwanted reflections on the ceiling. Thus, if the ceiling level is low, that is bellow 2.5. meters, it could be unsuitable to direct light upwards (Gardner and Hannaford, 1993).

Another problem could arrive if uplighting fixtures are used in areas where composed of two layers as having mezzanine floors: direct glare. Cove and bracket fixtures, or other uplighting fixtures could be efficient when

viewed from downstairs. However, from above not only the probability of direct glare increases, but paths of light would look unpleasant as well.

5.2.3. Lighting Systems

IES Lighting Handbook (1962) states that: "An important factor in the design skill requiring in lighting stores is the ability to apply properly the many basic or specialized types of lighting elements to a particular kind of merchandising area or store" (13-4).

A system or the combination of different systems to be used mostly depend on: the character of the store, the merchandise that is sold, and the atmosphere that is wanted to be created.

The lighting systems that are usually used in the merchandising areas can be grouped as: general lighting, display lighting, and accent lighting.

5.2.3.1. General Lighting

General lighting systems provide a uniform illuminance over the entire space. Parnes (1948) indicates that: "General lighting should produce an even, neutral illumination all over the store, including the traffic aisles, merchandising areas, floors, walls, and all other architectural surfaces" (233).

While arranging the general lighting of the merchandising areas, lighting level, color appearance, and color rendering properties have to be taken into account since they all together determine the overall characteristic of the retail establishment.

General lighting of the merchandising areas can be achieved by using different light sources. Figure 5.12. shows the variety of ways for the general illumination.

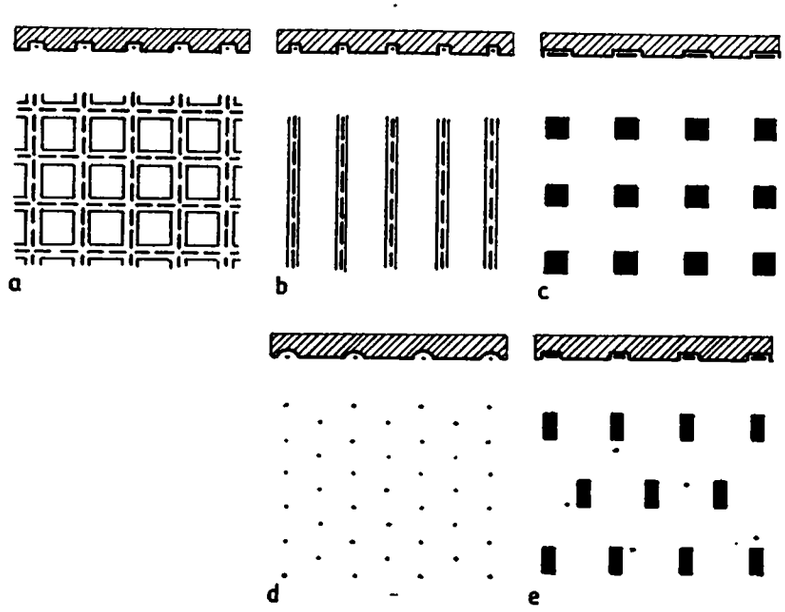


Figure 5.12. General Shop Lighting Provided By Recessed Ceiling-Mounted Luminaries

(Philips Lighting, 1993, p. 231).

According to Figure 5.12. the lighting systems are composed of: a) and b) single fluorescent lamps, c) groups of fluorescent, d) halogen or high-pressure discharge, e) mixed fluorescent and halogen lamps (Philips Lighting, 1993: 230).

Fluorescent light sources are mostly chosen to be used for the large areas in the selling environments, such as supermarkets or department stores. On the other hand, for the places which sell luxury goods, incandescent light sources are often preferred to be used as a general lighting.

For merchandising areas with low to moderate type of ceilings, general lighting can be obtained by using surface-mounted fluorescent fixtures. For high ceilings, pendent fixtures which have open-tops can be appropriate in order to achieve a uniform illumination.

5.2.3.2. Display Lighting

While general lighting helps to provide a diffused, overall illumination in the selling environments, the actual lighting for selling to catch the viewer's attention, is contributed by display lighting. Displaying merchandise could be in several ways such as on the mannequins, clothes that are hanging on the wall, on counter-tops or in show-cases.

It must be determined that the effective display lighting in the merchandising areas could not be possible by the general lighting: the merchandise may not get enough light to be differentiated from the surrounding. So the lighting systems are most commonly arranged particularly around the shelves and counters, or the display units can be lit from the inner side.

Display lighting could be analyzed under two following headings: horizontal display lighting and vertical display lighting. Countertops and the show-cases in the merchandising areas require horizontal display lighting whereas shelves, wall units or mannequins need vertical lighting.

Horizontal Display Lighting

It is a very useful way for the retailer to display some of the goods in the showcases because the glass is used to protect the display by keeping

away dust and dirt from the goods, at the same time gives opportunity to the customer to see the product. However, the glass on top has a potential to create unwanted reflections.

First of all, the objects displayed should be 3 or 4 times brighter than the general environment. In fact this is true for both vertical and horizontal display lighting (the appropriate brightness ratios are stated in the second chapter). Horizontal display units are usually lit from the interior either by fluorescent tubes or low wattage tungsten lamps in metal reflectors, in order to reduce reflections on the glass. Fluorescent emits a continuous line of light and since the heat radiated is not so high, the effect of the heat to the merchandise will be less. Cayles and Marsden (1983) states that:

> Fluorescent tubes or even low wattage high pressure discharge lamps, have the advantage over tungsten lamps for internal lighting in that they have a lower heat content. However, most of them have a higher ultraviolet content, which needs to be filtered out if the objects are more sensitive to radiation than to heat. All light sources and their control gear generate some heat and therefore internally-lit showcases must be ventilated, naturally or forced, whatever the source used (392).

If fluorescent lamps are intended to be used in the show-case, the ones with the small diameter have to be chosen so that they do not occupy so much space. For designs of irregular cases like circular or curved ones, cold cathode tubes or neon can be appropriate.

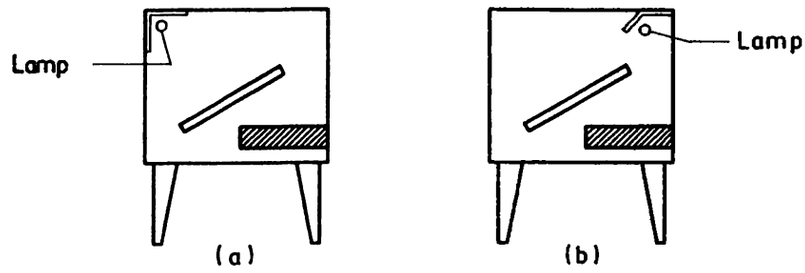


Figure 5.13. Methods of Lighting A Counter Showcase (Calyless & Marsden, 1983, p. 392).

In Figure 5.13., (a) shows the mostly used method of illuminating a showcase. This gives a good distribution of light. If the design of a showcase is made of slender framing it could be another way to place the lamps at the back of the showcase as seen in (b) If discharge lamp is used, the necessary control gear must be placed in a ventilated drawer, shown as the shaded area (Cayless and Marsden, 1983).

Downlighting, produced by the overhead fixtures, could be suitable for the illumination of the horizontal surfaces. If the merchandise is in a glass showcase, by placing the fixtures at the front edge of the counters, the possibility of glare is lessened. According to Grosslight (1990), the best selection for the downlighting fixtures are incandescent R and PAR sources in 50 to 300 watts, or white-sodium T-10 sources in 35 to 100 watts. There is more detailed information about downlighting in section 5.2.2.1.

Countertop lighting could be either direct or diffuse. If direct lighting is chosen, the light must be intense and focus directly to the product with using regular or low voltage incandescent sources. Grosslight (1990)

states that for regular voltage, it is required reflector spots in 25 watts or more according to the general lighting condition and a transformer is required for the low voltage one. But for both conditions, the lamps have to be adjustable since the displays change so quickly, the lighting could be changed accordingly.

Vertical Lighting: Many goods such as books, clothing, perfumes and others are displayed in vertical surfaces such as in shelves, wall-cases or they can be freestanding merchandise like furniture. These vertical displays require valance, cornice, luminous panel, or shelf-edge lighting.

For valances and cornices, whether they are opaque, luminous, or perforated, generally fluorescent light is preferred to be used (Sorcar, 1987 and Grosslight, 1990). They are very suitable especially for wall displays, clothing racks, and shelves, as can be seen in Figure 5.14.

Grosslight (1990) indicates about the distance such that: "Install the fluorescent tubes a distance out from the vertical display equal to one-forth of the distance over which the light is expected to fall. For example, if the display is 4 ft (1.2 m) high, the fluorescent source should be 1 ft (.3 m) out from the display" (181).

Another point has to be taken into account that, the iluminance level should be three to four times to circulation areas and illuminance ratio between the top shelf and the bottom one must not be more than 3:1 (Sorcar, 1990). Figure 5.14. represents the valance lighting.

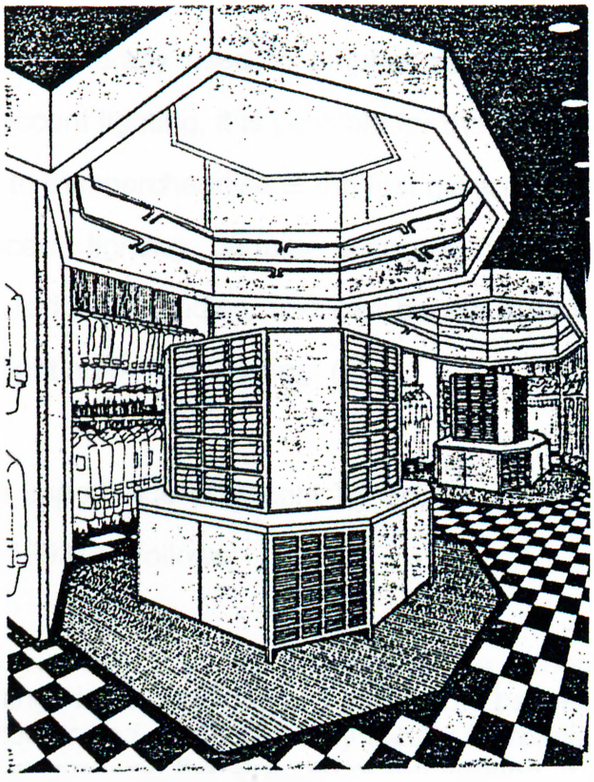


Figure 5.14. Valance Lighting for Vertical Displays (Grosslight, 1990, p.181).

The triphosphor 1 in. (25cm) diameter T-8 or compact fluorescent because; they even fit a small valance or cove space and have a good color (2700 K) and color rendering (81 to 87 Color Rendering Index), that is very important for the lighting merchandising areas.

In order to light the merchandise in the shelves, luminaries that are advised to be used depend mostly on the shelf edge. If the shelf edge depth is 3/4 to 1 in. (1.9 to 2.5 cm) low-volt lights in flexible or rigid tubes, or on tapes, if the depth increases to 4 in. (10.2 cm), MR (multi-faceted reflector) -11 or -16, compact fluorescent, or incandescent C (cone),T (tubular), or R (reflector) -14 spot could be appropriate (Grosslight, 1990).

5.2.3.3. Accent Lighting

Accent lighting is generally used to emphasize an object or particular areas. By using accent lighting, it is possible for the customer to focus his attention directly to the merchandise at the first glance. Parnes (1948: 237) states that: "Accent lighting permits accurate control of illumination intensity on featured merchandise, and can be adjusted to give any size and color of spotlighting or floodlighting" (237).

The aim and the importance of accent lighting is stated in International Lighting Review (1993) as follows:

> The purpose of accent lighting, unlike general lighting, is to strengthen the relation between customer and product . . . By locally increasing and decreasing the strength of the lighting, it is possible to create a varied brightness and shadow pattern, with contrasts that suggest dynamism. The harsher the shadows, the more dramatic and aggressive the effect obtained. The aim is to give maximum expression to form, structure, texture and color - in contrast with the surroundings (9).

Accent factor identifies the degree of the effect that is wanted to be created. "It gives the illuminance ratio of the object being lit to its immediate surroundings: Accent factor=E spot / E horizontal" (International Lighting Review, 1993: 9). Table 5.4. gives the ratio of accents. When an object is lit with an accent factor of 2, it means that it must be two times as bright as its background. Figure 5.15. shows the determined effects according to the ratios obtained.

Table 5.4. Guide to Accent Factors

Accent Factor	Effect
1:1	no accent
2:1	noticeable
5:1	low theatrical
15:1	theatrical
30:1	dramatic
>50:1	very dramatic

(International Lighting Review, 1993, p.9).

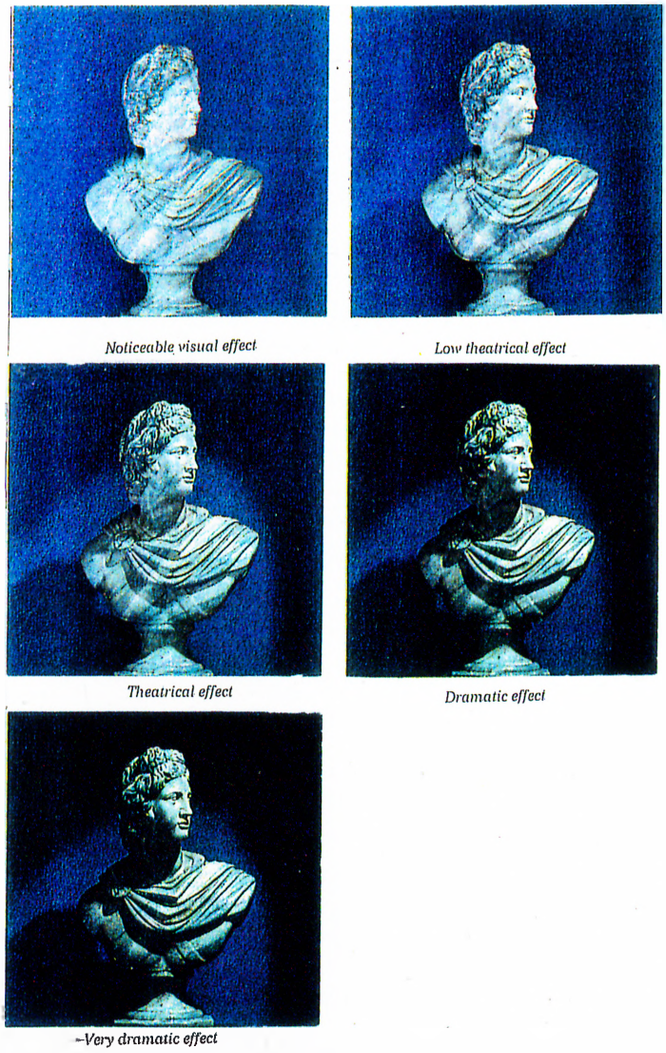


Figure 5.15. Examples of Different Effects

(International Lighting Review, 1993, p.9).

Accent fixtures that are used in merchandising areas have to be adjustable: they can be recessed, surface mounted or track fixtures. These fixtures are explained in detail in section 5.2.2.1.

6. GENERAL CRITERIA FOR LIGHTING MERCHANDISING AREAS IN SHOPS

General lighting criteria of the merchandising areas in shops can be classified in five main categories.

A. Basic Requirements:

1. The lighting that is used for the merchandising areas must never catch the attention to itself more than the merchandise. It must be noted that, the main thing is to sell the merchandise, not the lighting units (see page 67).

2. Flexibility is an important consideration for the lighting of merchandising areas. The lighting system must be flexible so that whenever the merchandise is changed or replaced, lighting could serve the changing needs of the selling environment (see page 60).

3. By the use of appropriate lighting, the merchandise must seem to be appealing, tempting, and must appear in its best appearance since it is stated as most people purchase just because they are impressed, without having buying decision in their minds (see page 45).

4. Light and energy must not be wasted by lighting bare walls or the floor. The light must be directed to the merchandise to be featured as it must be the center of the attention.

5. The most important requirement for the merchandising areas is the comfortable and easy perception of the goods on sale. However glare, the greatest enemy of the visual comfort, mostly occurs in shops obscuring the appearance of the products. For example, most common problem is the reflections from shiny surfaces causing discomfort and distraction in the visual field (see page 16).

B. Good Visibility Requirements:

1. The lighting units must be screened with baffles, louvers, etc. in order to protect the viewer from the direct glare and to reduce the extreme luminarie brightness (see page 18).

2. The lighting units must be located out of the visual field (see page 18).

3. While illuminating the desks or countertops, the location of the light sources on the ceiling must be in front of the customer so that the reflected light is kept away from the customer's eyes and her shadow does not fall upon the merchandise (see page 18).

4. Reflectance values of the materials have to be considered since too much bright surfaces cause glare. It is important also from the illumination point of view that; dark colored merchandises require more illumination than the light colored ones since they reflect less. Dimly

illuminated white surface seems brighter than the dark surface which is illuminated with high level of light (14).

5. Lighting level inside the store must be adequate for the customer's eyes to readapt the inner situation since they are coming from the outside condition. Illumination levels provided for the merchandising areas can be seen in Figure 2. Simply, it can be stated that circulation areas require one unit of illumination where as merchandising areas 3, special displays as counters or display cases need 5 units (see page 9).

6. The luminance levels in the merchandising areas have to be controlled. There are some specific luminance ratios between the display and its near surrounding. This is necessary because the merchandise have to be accentuated accordingly. The ratio between the displayed surface and the near surrounding must be at least 3:1, and must not exceed 4:1 (see page 8).

7. If it is required a noticeable transition between one area and another, one of them could be 10 times bright than the other. For the situations when a break in the lighting continuity is required, the ratio should be 3:1 (see page 8).

8. The modeling, that is created by directional lighting is necessary so that the texture and the form of the merchandise can be differentiated by the customer. Increase in the angle of incidence makes the material's texture more accentuated and creates a dramatic effect. However it will become difficult to perceive the object, while the angle decreases the possibility of reflected glare increases (see page 19).

9. The best modeling effect is achieved by using more than one source; light should come from different directions. Concentrated light emitted from a single point source casts strong shadows. These strong shadows obtained from one-directional light source not only is visually oppressive but also misleads customers about the shape or texture of the merchandise (see page 21).

C. Lighting Requirements For the Color Appearance:

1. Too much impulse colors are self defeating. When used in the background, they clash with the color of the merchandise (see page 28).

2. By the use of appropriate colors, materials and lighting, it is possible to create different optical illusions as if small stores are seem to look larger or lower ceiling are made to appear higher. In order to make a small space look larger, bright, light colors are to be used and the ceiling height is emphasized by using uplightings. Wallwashing uplights on a light color surface seems to increase the height of the ceiling, where as using pendant fixtures that directs the light downwards will make the ceiling appear lower. In order to make a narrow store look wider, a light color should be used on the walls with a reflective surface, the walls should be washed with light, adjustable ceiling fixtures such as track lighting should be used.

3. While selecting the appropriate light sources for the suitable appearance of the merchandise, cool light sources must be used with the high intensities, where as warm light sources with the low intensities. In addition to this, cool light sources contributes a dull, uninviting atmosphere. On the other hand, warm light sources are more

likely to be creating inviting, appealing and cheerful impressions (see page 38).

4. Warm light sources accentuate yellow, orange and red hues and deficient in blue, green ones because of being at the red end of the spectrum. On the other hand, cool light sources enhance violet, blue, green hues better than red, yellow ones. That's why, a red textile appears grayed when viewed under cool fluorescent light (see page 36).

5. Regarding the human appearance, cool light sources make the human complexion pale and unnatural. On the other hand, warm sources enhance the pink, rosy look on the faces (page 40).

6. Colored light should be used carefully on the merchandise because it distorts the exact color of the merchandise. However, it is mostly preferential for creating different background effects. Background colors of the display units must enhance the effect of the product displayed rather than camouflaging it (see page 38).

7. Shortwave region of the spectrum has the damaging effect on the products on the displayed merchandise as fading, discoloration, or disintegration. Since artificial light sources emit unequal quantities of wavelengths from the visible spectrum, some of them emit radiation having more ultraviolet content. Daylight has a much higher proportion of UV than the electric light sources. The effect can be minimized by using filters (see page 40, 41).

8. As stated, daylight is responsible for the occurrence of fading. so the merchandise that is exposed to daylight or to the sun all day, particularly in the shop windows, has to be replaced often in order to reduce this effect (see page 43).

D. Requirements For the Shop Windows:

1. First of all, type of the window has to be determined whether it is open or closed back. For the open one, it is difficult to conceal the lighting fixtures since both the front and the back sides of the shop window, open to view. Thus, ceiling recessed fixtures are to be preferred for this type. For the closed back windows, it is easy to hide the fixtures from the view of the customers (see page 47).

2. In order to have the sufficient view of the merchandise inside the shop window, the obscuring effects of daylight to the shop window have to be avoided (see page 51).

3. Especially for the daytime, illumination of the window interior must be higher than the brightness of the reflected external images, so that the displayed items can be perceived properly. It is necessary nearly 5.000 to 10.000 lux for the daytime illumination while 2500 to 5000 lux is appropriate for the night time lighting condition inside the window (see page 52).

4. Veiling reflections which are occurred by daylight can be reduced on the window by having different treatments of glass. Other than locating it vertically, it is possible to curve the glass or to tilt it forwards and backwards. The common point is using dark canopy, or soffit above the

window or dark pavement in front of it so that the light can be absorbed and diminished by these black surfaces. Furthermore, the shadow of the dark canopy cast on the window glass makes the merchandise appear clearly. The chosen slope of the window glass will be appropriate from the visibility point of view; if the slope is 90 degrees to the bisector of the angle that combines the light coming from the edge of the soffit to the window base and than to the customer's eye, and if the edge of the canopy is seen at the bottom of the glass pane. In spite of being so costly, curved glass in section eliminates all the reflections and appears as an invisible glass (see page 54, 55, 56).

5. Canopies and blinds are advised to be used because they are protecting merchandise from the fading effect of sunlight on the merchandise (see page 59).

E. Requirements For the Selection of Light Sources, Lighting Fixtures and Lighting Systems:

1. The light source that is going to be used in merchandising areas should be selected so that the product can be viewed in its best appearance (see page 67).

2. Incandescent light sources produce bright, sparkling quality of light and casts shadows that could aid for the perception depth of the product. They generally used as a point source, illuminating a specific object or a product (see page 77).

3. Low-wattage tungsten halogen lamps should not be used in series because they produce so much heat (see page 78).

4. Human appearance is important for some merchandising areas, especially for the cloth or cosmetics shops. In these kind of stores, the customer wants to see herself with the product if it suits or not, and inspect the color, form of the merchandise from the mirror. Thus, lighting of mirrors needs a special consideration. First of all, light sources chosen to be used must flatter the skin tones. Secondly, the illumination quality must be nearly the same as the place that the product to be appeared. Thirdly, the light has to illuminate the customer, not the mirror. It is stated by IESNA (1986) that: "Luminaries should be mounted outside the 60- degree visual cone the center line of which coincides with the line of sight" (198). It is also stated that the luminaries luminance must not exceed 2100 candelas per square meter.

5. HID sources must be chosen for the areas where the necessary color discrimination is not important because of their poor color rendering quality (81).

6. Wallwashers illuminate vertical surfaces where as downlights are used to illuminate horizontal surfaces. Wallwashers provide diffused illumination. They have to be placed 1 meter away from the wall and each other. They can illuminate 1.5 meter down the wall. Specular surfaces must not be lighted by wallwashers since the probability of glare occurrence is high (see page 87).

7. Track lighting is very useful for the merchandising areas because they meet the flexibility requirements. The lighting units that are hung on the track could be moved both vertically and horizontally (see page 88).

8. Cove fixtures produce diffuse illumination and are appropriate for the general lighting of the merchandising areas. They are mounted on the wall, 0.45 to 0.90 meter below the ceiling. Cove fixtures must not be used in places with mezzanine floors while effective from the ground level, nothing is more ugly than a row of dazzling uplighter dishes seen from above. To uplight a space, the required ceiling height must at least be 2.50 meter (see page 91).

9. The horizontal display units have to be illuminated from the interior so that the reflections from the outer sources don't obscure the merchandise appearance. For the interior of the show-cases fluorescent and low-wattage high pressure discharge lamps are used, because they radiate less heat particularly for the heat sensitive merchandise. On the other hand, since they have UV content, the sources have to be filtered. Nevertheless, the interior of the show-case have to be ventilated to avoid the heat increase of the light sources (see page 96).

10. Valance and cornice lighting is mostly used to illuminate the vertical displays, such as the merchandise that are placed in the shelves. They can be opaque, luminous or perforated and the fluorescent lamps are suitable for this type of lighting (see page 98).

11. In order to understand the most suitable lighting system for the merchandising areas; character of the store, the type of the merchandise sold, and the image wanted to be created are determining points (see page 93).

12. General lighting must be used with the display lighting; because of being so diffuse the goods need to be accentuated by display lighting.

Incandescent light sources are used for general lighting in places where they sell luxury goods, whereas fluorescent are preferred mostly for the department stores and supermarkets (see "Four-corner philosophy diagram" in page 75).

13. Lighting merchandising areas offers a great opportunity to create different visual effects in the environment. Accent factor stress out the illuminance ratio of the object being lighted to its near surrounding. Accent factor of 1:1 have no accents, 2:1 have noticeable, 5:1 creates a low theatrical effect, 15:1 theatrical effect, 30:1 dramatic effect, and more than 50:1 creates a very dramatic effect in the store environment (see 100, 101).

7. CONCLUSION

The main purpose of this study is determined as to point out the lighting design criteria of merchandising areas in shops. Throughout the study, merchandise lighting has been studied from different points of view and it was found that there is really a need to identify several requirements as a list which could be a guide for the design of the lighting plan for the merchandising areas as it was intended to be done in the introduction.

It can be said that what is important for store lighting is to bring the merchandise into the right light, with the appropriate lighting effects. The lighting system must be arranged so that it could meet the necessary requirements, otherwise as Fitch and Knobel (1990) mentions, the obvious result would be: "Without good lighting, any retail design is condemned to failure" (78).

Due to this fact, lighting design of a store can be considered as successful if it attracts viewer's attention, initiates purchase and helps to complete the sells. The main purpose lies behind the constitution of these criteria is to meet these lighting objectives.

Merchandising environment can be widely varied from a small shop to a large department store, that is, each could sell different merchandise from flowers to automobiles. Lighting criteria which are established covers general basic requirements that have to be taken account while designing

the lighting plan of all these different shops. Based on the criteria, there are several factors which influence the lighting design decisions which has to be given.

It has been stated that in order to attract attention, determination of the luminance (brightness) ratio of the merchandise and its immediate surrounding is vital. These ratios have to be considered since if they are exceeded the required values, the possibility of glare increases and the customer can not perceive the merchandise well. If the level is kept lower than the required, than the merchandise can not be differentiated well.

Avoidance of glare is an important factor in order to have the optimum visibility, when the lighting design decisions are given.

The illumination levels in merchandising areas are important because not only sufficient illumination is necessary in order to see articles well, but the shop has to compete with the other adjacent shops as well. It has been noted that, the size of the shop or the shop window does not effect the required illumination level. The shop window dimensions have been stated in order to give a general idea while designing the window.

Intended color appearance of the merchandise contributes to the increase of the sales. In some cases, provision of the appearance of human complexion has the equal importance. Type of the light source that is used in the selling environment is directly responsible for the different appearances of the colors. Therefore, the selection must be done accordingly.

Fading that is caused by the UV radiation, has been considered as the most important effect of light on the merchandise, especially for the sensitive materials. It discolors the appearance of the merchandise and may cause perishing. It has been found that, solar radiation has more UV content than the artificial light sources so merchandise that is displayed especially in the shop windows has more risk of fading. Therefore, the probability of fading must be regarded for the constitution of the lighting plan.

It was also found that flexibility is one of the most important factors while selecting the appropriate lighting equipments or arranging the lighting system. Since the goods on display changes so often, the lighting system should be flexible enough to suit these changes. In other words, when the merchandise itself or the place of the display system is replaced, lighting must be enable to suit these changes.

Effects of daylight to the shop windows, other than fading are the veiling reflections that obscure the merchandise visibility. It has been determined that, while tilting the glass by obtaining the necessary slope, it is possible to avoid these unwanted reflections, furthermore it seems like no glass exists.

In the design of the lighting merchandising areas, the selection of the lighting fixtures plays an important role to illuminate the merchandise. The chosen fixture must be appropriate for the illumination of the display unit whether it is horizontal or vertical. Moreover, the lighting fixture or the light itself must never take the attention on themselves, rather than the merchandise. It has been stressed out that lighting is a tool to attract attention.

It has also been obtained from the preceding chapters that using only general lighting in the merchandising areas is not enough. Display lighting is a must in shops in order to provide accent to the merchandise.

Within the framework of this study, all these factors are concentrated on the importance and the need for a careful planning of the lighting design in merchandising areas. This study is compiled from related publications and is tried to present a general overview to lighting merchandising areas and is stressed out some necessary lighting requirements which are valid for all kind of stores.

Based on this subject, further studies could be done in order to obtain more specific results. By doing case studies, it is possible to search for the lighting requirements for a particular establishment like a jewelry shop or a supermarket. Moreover, it could be aimed to analyze the shops in Ankara from the lighting point of view by making comparisons between several significant shops.

I hope, the general criteria that are obtained from the study could be helpful for the designers while determining the lighting plan of shops and leads them to design consciously lighted spaces.

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APPENDIX

Vocabulary

A

Accent lighting: Directional lighting in order to emphasize an object or draw attention to a part of the field of view.

B

Baffle: It is an opaque or a translucent element in order to shield the source from the direct view at certain angles, or to absorb unwanted light.

Ballast: A component of the control gear of a discharge lamp which limits the current flow.

C

Can: Term for the normally cylindrical housing of a reflector lamp.

Candela, cd: The unit of luminous intensity.

Color Rendering: The effect of a light source on the color appearance of objects in comparison with their appearance under a reference light source.

Color Rendering Index (CRI): Indexing measure of how colors under a particular light source compare with the same colors viewed under a standardized illuminant.

Color Temperature: The absolute temperature at which a black body radiator must be operated to have a chromaticity equal to that of the light source.

Contrast: Subjective experience of comparative brightness between two luminances, seen simultaneously or successively.

Control Gear: The ancillary components of a discharge lamp, comprising ballast, starter, ignitor, capacitor, etc., which regulate the electrical energy flowing into the lamp.

Cut-off Angle (Shielding Angle): (of a luminaire) the angle from the vertical at which a reflector, louver, or other shielding device cuts direct visibility of a light source.

D

Diffuser: Translucent or frosted screen covering a light source, so that light is distributed evenly.

Direct glare: Glare resulting from inadequately shielded light sources occurs in the field of view.

Discharge lamp: A lamp in which light is produced directly or indirectly by an electric discharge through a glass or vapor.

Downlighting: The technique of lighting a space primarily from high level sources directed down onto the floor or work surface.

F

Filter: A piece of translucent gel or glass which, when placed in front of a white light source, cuts out selected spectral emission. For example,

ordinary, ordinary plain glass acts as a filter to some ultraviolet radiation, while a colored gel cuts out all light waves except those of the desired color.

Floodlight (floodlamp): Any luminaire which emits a broad beam of light.

Fluorescent Lamp: A low pressure mercury electric discharge lamp, tubular in shape, in which a fluorescing coating (phosphorus) transforms ultraviolet energy into visible spectrum.

L

Louver: A series of baffles used to shield a source from view at certain angles, or to absorb unwanted light.

Low-voltage lighting: Light systems where the voltage has been stepped down from 240V to a 'safer' 12V or 24V, using a transformer.

Lumen, lm: a measure of light output emitted from a source. It is a unit of luminous flux.

Luminaire Efficiency: The ratio of luminous flux (lumens) emitted by a luminaire to that emitted by the lamp or the lamps used there in.

Luminance Contrast: The relationship between the luminances of an object and its immediate background.

Luminous Efficacy of a Source of Light : The quotient of the total luminous flux emitted by the total lamp power input. It is expressed in lumens per watt.

Lux, lx: SI unit of illuminance.

M

Matt Surface: A non-lustrous surface that reflects incident light totally evenly all directions.

Mercury Lamps: A type of discharge lamp where light is produced by exciting vaporized mercury.

Modelling: The effect of using highly directional light to create form through shadows and highlights.

N

Nits: SI unit of luminance.

P

PAR Lamp: A lamp with a sealed beam and an aluminized parabolic rear surface, which acts like as an effective integral reflector.

Photomertic Brightness: The amount of footlamberts emitted or reflected from a light source or surface.

R

Reflected Glare: Glare resulting from specular reflections of high luminance in polished or glossy surfaces in the field of view.

Reflector: A device used to redirect the light by the process of reflection.

S

Soffit: The exposed undersurface of any overhead component of a building, such as an arch, beam or cornice.

Spectral Composition: The unique combination of spectral colors of a light source which determines its color appearance and color rendering properties.

Specular Reflection: The reflection of light from a mirror-like surface.

U

Ultraviolet Radiation (UV): Electromagnetic radiation beyond the violet end of the visible spectrum, which can damage painted and dyed colors. The plain glass envelope of most lamps filters out some of the ultraviolet radiation. It is important in fluorescent lamps, where most light is created when ultraviolet radiation from the discharge process excites light-emitting phosphorus on the inside of the glass.

Uplighting: A technique of indirect lighting where light is directed upwards so that most of it reaches the working plane indirectly after being reflected off the ceiling and walls.

V

Veiling reflections: Reflections which partially or totally obscure the details to be seen by reducing the contrast.

Visual Field: The location of objects or points in a space which can be perceived when the head and the eyes are kept fixed.

Volts/voltage: Measure of the potential difference that drives the electric current through a circuit.

W

Watts/wattage: The standard unit of electrical energy